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The Magazine of Metallurgical Engineering

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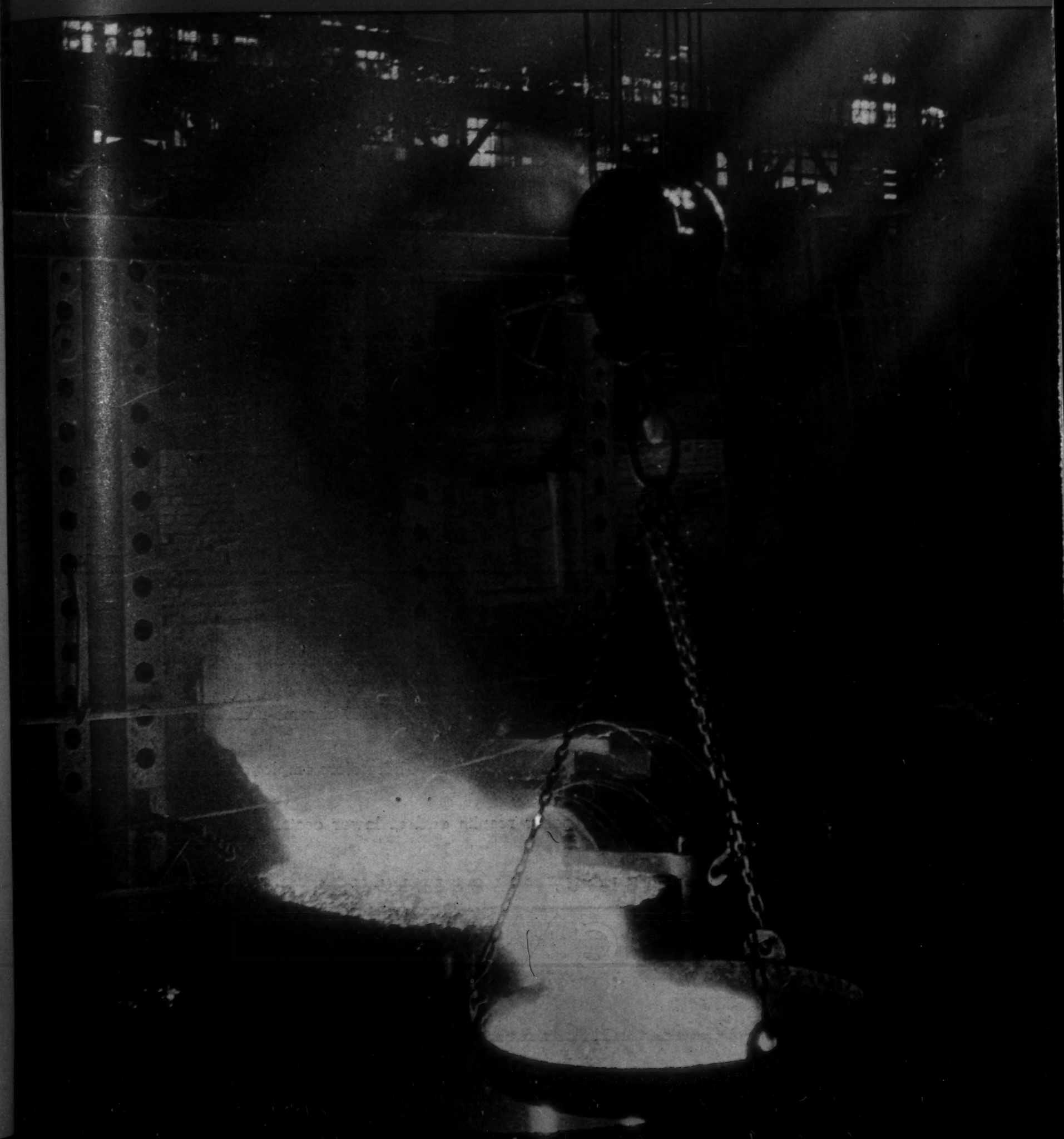

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METALS & ALLOYS

The Magazine of Metallurgical Engineering

Production • Fabrication • Treatment • Application

PUBLICATION OFFICE:
1117 Wolfendale St., Pittsburgh, Pa.

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WM. P. WINSOR, Advertising Manager

Editorial and Advertising Offices:
330 West 42nd St., New York, N. Y.

Branch Office:
706 Straus Bldg., Chicago, Ill.
G. E. Cochran **R. M. Creaghead**

Published Monthly by
The CHEMICAL CATALOG CO., Inc.

Ralph Reinhold, Pres.-Treas.
Philip H. Hubbard, Vice-Pres.
H. Burton Lowe, Vice-Pres.
Francis M. Turner, Vice-Pres.

Annual Subscription: U. S., Possessions, $3.00; Canada, $4.00; All Other Countries, $8.00 (Remit by New York Draft). Single copy 40 cents. All communications relating to subscriptions or back issues should be addressed to METALS & ALLOYS, 330 West 42nd Street, New York, N. Y.

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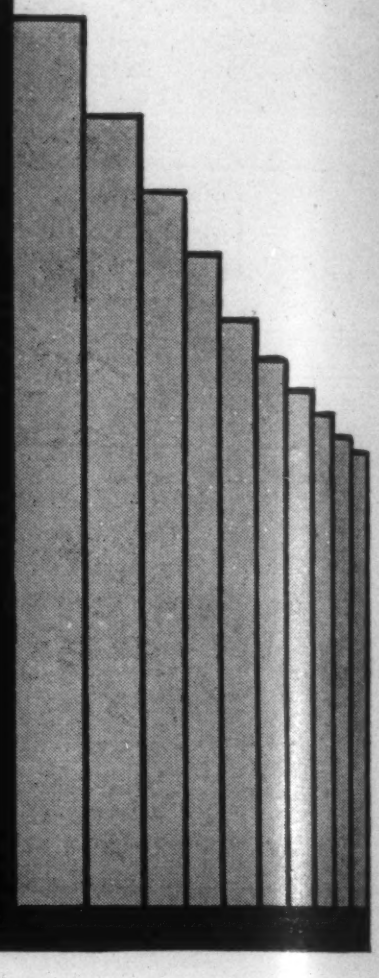

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HIGHLIGHTS

by H. W. GILLETT

Physical Chemistry of Steel Making

The "physical chemistry of steel making" used to sound high-brow, but today is recognized as of immediate and practical importance. German lore and German practice are summarized in a book by Schenck. (page MA 126 R 1)

Electric Melting

Electric melting gets attention. Wotschke has written a noteworthy book on the design of large smelting and melting furnaces, and the A. F. A. discusses the complicated matter of costs of electric energy in foundries. (page MA 139 L 1)

Rolled Threads

Bolts with rolled threads and made in special forms stand up better under repeated load, according to extensive experiments by Staedel. (page MA 150 L 1)

WARNING!

We have been asked to select the abstracts that seem of the most immediate interest to the practical operating man, and run them at the beginning of each section of the classification, rather than mixing them in indiscriminately. We are acting on this suggestion, though it has elements of danger. No one can tell what bit of information a given reader may prize most. Tomorrow he may have vital need for something he would not today class as of any interest.

So if the practical reader should form the habit of reading only the abstracts toward the head of each section and thereby misses important data that appear further down, our effort to be helpful would have the opposite effect. We give warning that we make no claim to infallibility and that the reader should glance over *all* the abstracts in order to be led to *all* the published information.

Molding Sand

Claus & Behrendt (page MA 123 L 9) show that a molding sand of low permeability is helped by venting, which sounds reasonable. Deitert and Valtier discuss the effect of the shape of sand grains on the closeness with which they pack, and hence on permeability. (page MA 121 L 3)

Machineability

Screw stock behaves differently according to how much metal is removed, says Graham. Comparative machineability may thus be reversed under different conditions. (page MA 131 L 1)

Strip Rolling

If you want to spread the strip as well as lengthen it in strip-rolling produce friction between strip and rolls, say Lueg & Osenberg. (page MA 129 R 1)

"Atlas Metallographicus"

Metallographers will be interested to know that Hanemann and Schrader's "Atlas Metallographicus" is now complete as to iron and steel and that an index to the various sections is now available. (page MA 152 L 1)

"Book of the Month"

We pick Brearley's "Steel Makers" as the metallurgical "book of the month." (page MA 166 L 2)

Electric Furnace Electrodes

Behling thinks that graphite electrodes are better than carbon for the electric steel foundry. (page MA 140 L 1)

Scabby Castings

According to Nilsson, scabby castings may be due to the expansion of quartz in molding sand on heating, so the sand should be blended with a material that will contract and counteract this tendency. (page MA 121 L 1)

Coke Combustibility

The combustibility of coke comes up again, Broche & Nedelmann claiming that laboratory tests at low temperatures tell nothing about what actually happens at blast furnace and cupola temperatures. (page MA 136 R 1)

Special German Dictionary

Are you struggling with metallurgical German? A special dictionary by Freeman is now available. The reviewer says it's good. (page MA 166 L 8)

Rolling Oil

Krekeler discusses rolling oils for Al sheet and strip. Reduction in the later passes on foil is dependent on the oil used. (page MA 130 R 1)

Heating Steel

How fast dare we heat steel? Keller discusses this from practical and theoretical viewpoints. (page MA 138 R 1)

Open Hearth Flames

How does the flame in an open hearth direct itself, and how should it best be directed, are questions Kofler and Schefels seek to answer by experiments on a 70 ton furnace. (page MA 137 L 2)

Big Forgings

Big forgings, from 100 ton ingots, in carbon and alloy steels were studied by Maurer & Korschan as to properties, grain size and flakes. This is far from a "test tube" type of experiment. (page MA 130 L 1)

Heat Resistant Alloys

Lauster prefers a 30% Cr 5% Al 65% Fe alloy to the usual NiCr for heating elements in electric heat treating furnaces. (page MA 137 L 1)

Compressed Metal Powders

Foundrymen and machine shops will have less work to do as the manufacture of parts from compressed metal powders advances, says Hardy. (page MA 166 L 1)

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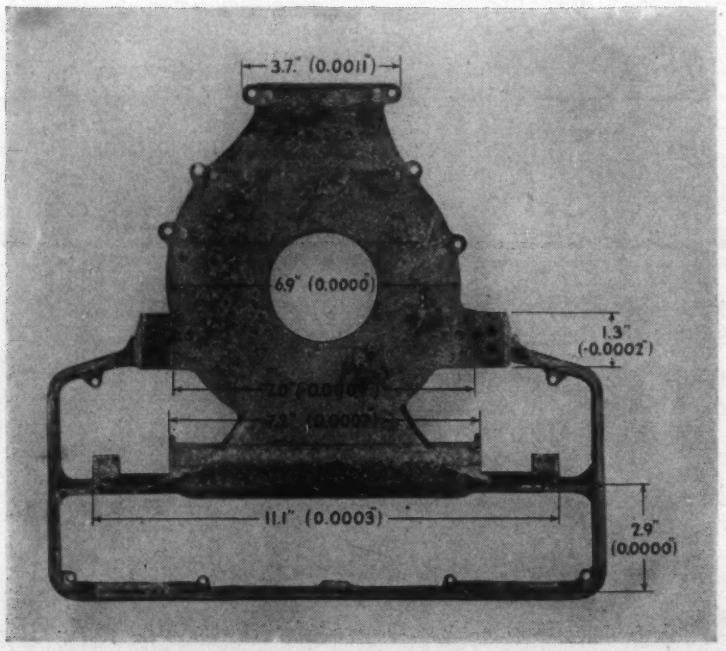
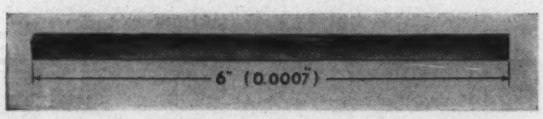
Zinc Alloy Die Castings at the Equator

"*'IT isn't the heat, it's the humidity,' says the wise cracker. But we take him seriously. A tropical sojourn during the rainy season, or a continuous Turkish bath have been simulated in the so-called steam test. Any of these alloys (Zamak,† Zinc Die Casting Alloys) will stand ten days in this test and there is a youngster coming along that isn't phased by six months in this test, a day of which will do to many alloys what a year at the equator will do.*"*





†Zamak is a registered trade mark applied to die casting alloys manufactured by The New Jersey Zinc Company from HORSE HEAD SPECIAL (99.99+%) ZINC. The formulas for these alloys are covered by patents owned by The New Jersey Zinc Company. Licenses to make these alloys with HORSE HEAD SPECIAL (99.99+%) ZINC under these patents have been granted to a number of manufacturers of alloys and certain commercial die casters who make their own alloys.

*From a paper delivered by Mr. W. M. Peirce before the Detroit Branch of the A. S. M., March 12, 1934.

Of course the research measurements have been made on die cast test bars and the results given in inch of expansion in six inches. The accompanying photograph of a commercial ZINC Alloy Die Casting (Zamak3) showing the expansion over certain measurements after ten days in steam at 95° C. is a very interesting comparison.

COMMERCIAL DIE CASTING		
Span	*Expansion*	*Expansion per Inch*
6.9"	0.0000"	0.0000"
3.7	0.0011	0.0003
7.0	—0.0009	—0.0001
1.3	—0.0002	—0.0000
7.2	.0.0007	0.0001
11.1	0.0003	0.0000
2.9	0.0000	0.0000
TEST BAR		
6"	0.0045"	0.0007"

NOTE:

All ZINC Alloy Die Castings undergo a shrinkage amounting to about 0.0005 inch per inch. This develops to completion in 5 weeks at room temperatures or 3 hours at 100° C. The sweeper chassis being a new die casting went through this stage of shrinkage during the steam test with its ensuing expansion to yield the values shown. The test bar data was obtained on bars after the shrinkage had taken place and so represent only the actual expansion.

THE NEW JERSEY ZINC COMPANY
160 FRONT STREET NEW YORK

EDITORIAL COMMENT

Outdoor Weathering

VARIOUS committees of the American Society for Testing Materials have been carrying out observations on the rusting and corrosion of iron and steel, non-ferrous metals and alloys, coated and electroplated hardware, etc., at representative locations throughout the country. Some under-water tests in fresh, brackish and sea water have also been included on some materials. The locations vary from rural, through industrial (smoky), on to sea coast locations in moderate and warm climates. Some of the exposure tests have been under way for eighteen years and are still continuing, while others have only been started in the last year or two.

At the Washington Regional Meeting, the A.S.T.M. took a day off and considered the exposure tests as a whole from the engineering point of view. In this Symposium, it was frankly recognized that the average scientist and the average technical committee tend to be very conservative and loath to draw even tentative conclusions till the last specimen has failed. The engineer has to make his decisions without waiting eighteen years, more or less, and figures that the differences in materials that really count are those that come out and hit you in the eye fairly early in the test. When differences are so fine-haired that one is in doubt which of two materials is really superior, the engineer will be guided by the respective prices, or at equal prices, he'll toss a penny and quit worrying about a choice.

The Symposium summarizes the facts that do hit you in the eye, such as the value of heavy zinc coatings, the utility of copper-bearing steel for atmospheric exposure, and its usual lack of superiority in under-water service, the uselessness of Parkerizing for outdoor use, and the longer life of zinc coatings than of cadmium coatings. One of the most valuable features of the discussion is the clarity with which it is brought out that environment often affects life to a more important extent than composition. The differences in behavior at different locations are so brought out that the engineer can make a pretty good stab at figuring which exposure location is most like the one he has to deal with. For example, we would feel quite justified in the assumption that corrosive conditions, or rather the lack of them, at our own Canadian camp, so closely parallel those at the State College, Pa. exposure location that we could apply the State College data quite directly to some problems of our own.

An interesting point is that metals in contact under exposure conditions rarely act the way they would be expected to from the electrochemical series. Attention is focused on the effect of condensed moisture, smoke and salt air, on the facts that recorded rain-fall doesn't necessarily tell much as to the prevalence of damp conditions that are harmful, and on the importance of the conditions obtaining through the first few days or weeks of exposure.

But probably the most important thing about the whole batch of papers is their complete silence about "accelerated laboratory tests." Some of the committees have made lots of these, usually with very little of engineering utility to show for their pains. That every one of the half dozen papers makes the tacit assumption that the real way to study outdoor weathering is to make outdoor weathering tests and didn't even bother to refer to short-cut tests, made under other conditions, which so often tend to mislead the student of the literature, is a really important thing. Of course, an accelerated test that actually gives results placing every material tested in the same order, and similarly spaced as to performance, as is found in actual exposure, would be worth while. It is a healthy thing that the exposure tests are available and are being used to evaluate the short-cut methods. For example, Strausser* evaluates the salt spray, intermittent immersion and ferroxyl tests for plated coatings, by their relationship to the actual A.S.T.M. exposure results, showing quite clearly that the qualitative information on pinholes given by the ferroxyl test is of far greater engineering utility than the pseudo-quantitative results of the salt spray test.

It is a pity that a summary of the long-drawn-out soil corrosion tests of the Bureau of Standards which have been reported periodically in such guarded terms as to make the reader put a rather unnecessary amount of time on study of data in order to draw any conclusions of utility, was not included in the Symposium. The lessons of that series of tests fit in very patly with those from the A.S.T.M. work. The Bureau's exposure tests on duralumin have been sufficiently summarized elsewhere.

These long-term investigations carried out by impartial organizations like the A.S.T.M. and the Bureau of Standards have immense value. As the findings percolate into users' minds, there will be less opportunity for inaccurate sales propaganda of the "classical" type to exert any effect.

There is need for other long-time investigations of a similar type on the behavior of hot and cold water piping in the waters of various cities, and on the performance of culverts in service. These subjects have often been proposed for joint study but it always seems nearly hopeless to get the warring factions into agreement. Yet these factions are each spending money on tests and surveys of their own that, no matter how comprehensive and how true the findings may be, will not be believed by the public to anywhere near the degree they would were the work done by an organization whose impartiality is inherent in its make-up, and which is so permanent in its nature that it can be certain to see the program through.—H. W. GILLETT

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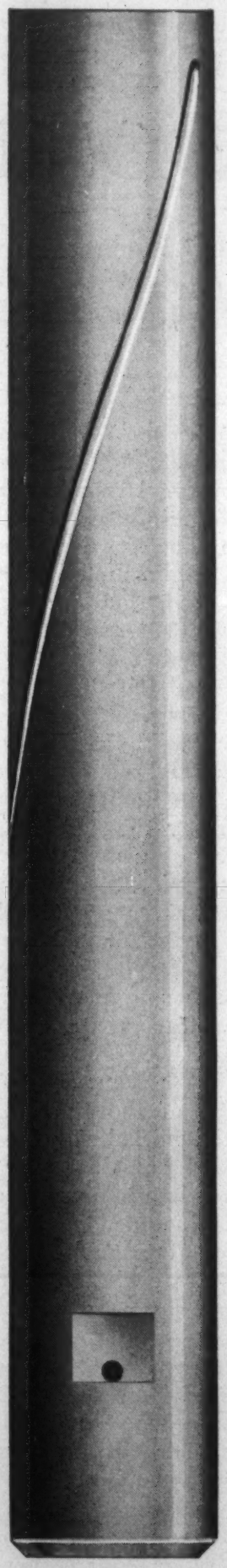
*P. W. C. Strausser. Accelerated tests of electroplated coatings on steel. *Monthly Review, American Electro Platers' Society*, January 1934, pages 6-10.



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Action of Fluorspar

on Open Hearth Basic Slags

A Correlated Abstract by Lenher Schwerin

Pouring a Test Ingot During the Heat
(Courtesy The Midvale Company)

One of the most interesting and amazing things in steel making is the action of fluorspar in "thinning" open hearth slags. Enormous amounts of spar are used in basic open hearth practice (about 6 pounds per ton of steel produced) but nobody knows the "why" of its action. If all the spar used were laid end to end——. Anyhow, as a technical subject there is plenty to discuss and the author has covered the field thoroughly. Theories of fluxing, desulphurization, and dephosphorization are discussed with reference to experimental work, both in the laboratory and in the open hearth, and to high flown theories. Some of the conclusions reached by various investigators can readily be shown to be incorrect for practices other than those investigated, which only goes to show that there is lots to be found out about our helpful friend fluorspar.—C. H. Herty, Jr.

THE purpose of this paper is to summarize critically the facts and theories which have been published concerning the behavior of fluorspar in basic slags. Since the action of fluorspar in glasses and enamels, to which it is sometimes added, may throw some light on its behavior in basic slags, a few pertinent observations will also be included herein.

Fluorspar is the commercial term for an ore containing fluorite as the chief constituent. Fluorite is a non-metallic mineral, calcium fluoride, whose composition is represened by the chemical formula, CaF_2. It occurs as cubic crystals which may be colorless, yellow, violet, pink or green, having a vitreous luster. It has a specific gravity of 3.18 and is insoluble in water. It is relatively soft, ranking 4 on Moh's scale of hardness, is quite friable, and decrepitates when heated to between 200° and 300°C. Its melting point is variously given as 1360° to 1378°C.* Fluorspar used for metallurgical purposes commonly contains 85% or more calcium fluoride and 5% or less silica. The balance is mainly calcium carbonate.

The principal use of fluorspar is as a flux added to slags in the basic open-hearth and electric furnace processes for making steel and in the cupola furnace melting iron. Its primary function is to lower the viscosity of the slag. It aids in the removal of sulphur and phosphorus from iron and steel, indirectly by decreasing the slag viscosity, and directly by forming compounds containing phosphorus and sulphur which may enter the slag or escape by volatilization. Fluorspar makes it possible for a slag to have a high lime content without being excessively viscous, a fluid slag being more reactive than a viscous one.

*Note: Melting points from International Critical Tables, Vol. I, First Edition, 1926, McGraw-Hill Book Co., New York. Other physical properties from any standard mineralogy such as Dana's Textbook of Mineralogy, Fourth Edition, 1932, John Wiley & Sons, Inc., New York.

Fohs[1] has written, "In the basic open-hearth process fluorspar is used to facilitate the liquefaction or thinning of the slag." Jones[2] explains further, "The limestone slag, immediately after the heat is melted, lies like a blanket upon the bath and to insure proper oxidizing conditions it is necessary to thin up the slag, and render it more fluid so that the metallic contents of the bath will come into more intimate contact with the oxidizing slag. It is the universal practice in this country to use fluorspar for this purpose." Ladoo[3] quotes Bostwick, who says in part, "The chief purpose of the fluorspar is to render the slag sufficiently fluid so as to hasten the transfer of heat from the flame to the steel beneath the slag, which reduces the time or duration of the heat, and that the slag may flow from the furnace without difficulty at tapping."

That there exists very little exact knowledge concerning the fluxing action of fluorspar becomes evident when one encounters the numerous contradictory statements made in the literature. Thus, Ladoo[3] says, "The chemical reactions which occur when fluorspar is used as a flux are not well understood, and authorities differ not only as to the chemical reactions but also as to the role fluorspar plays in smelting and the nature of the results obtained."

The controversial questions that have been raised and which will be discussed include loss of fluorine from the slag, and the effect of fluorspar upon the viscosity of the slag and upon desulphurization and dephosphorization of the metal.

Loss of Fluorine

There seems to be general agreement that all of the fluorine introduced by fluorides into slags, glasses and enamels does not remain there. However, we find diverse opinions regarding not only the extent to which the fluo-

rine is removed, but the mechanism by which it leaves. In some cases, several of the reactions to be discussed may proceed simultaneously. It is generally accepted that the loss of fluorine is due to volatilization.

Kitaigorodskii and Kurovskaya[4] list 4 possible causes of volatilization of fluorine during glass melting, as follows:

1. Formation of silicon tetrafluoride, SiF_4.
2. Volatilization in the form of molecular fluorine.
3. Sublimation of undecomposed fluorides.
4. Formation and evaporation of hydrogen fluoride, HF.

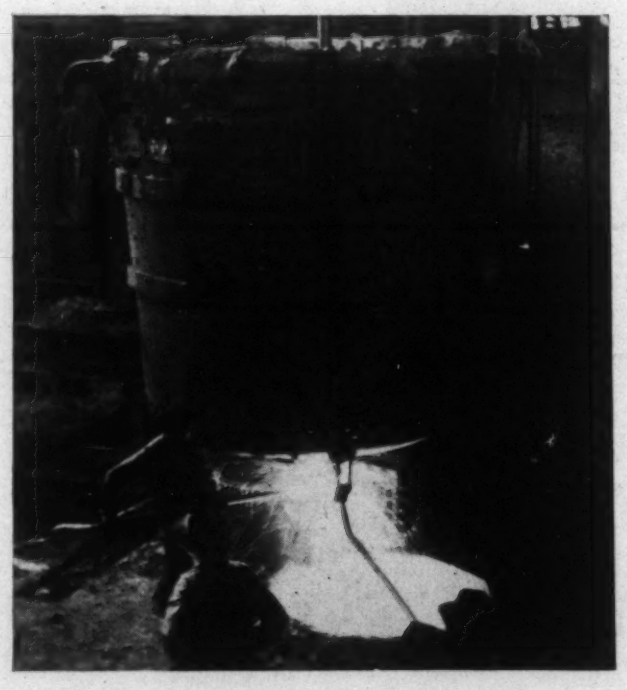
This list might be extended to cover the case of slags by adding one more possible cause:

5. Formation of other volatile fluorine compounds
   a. Fluorides of metals
   b. Fluorides of non-metals.

When silica is present in these melts, the evolution of silicon tetrafluoride is quite well established. The reaction

$$2CaF_2 + SiO_2 = 2CaO + SiF_4$$

is supported with some experimental evidence by Schleicher,[5] Sisco,[6] Osann,[7] Pukall,[8] Geiger,[9] Herty et al,[10] and Dauvalter.[11] After the addition of fluorspar to a basic open-hearth furnace, Schleicher[5] has observed dense white fumes covering the slag and issuing from the stack. When the gases from the furnace were passed through water, a gelatinous precipitate of silicic acid was obtained. He has also shown that samples of slag taken just before and within 5 to 10 minutes after the addition of fluorspar show that the fluorspar additions have significantly lowered the amount of silica in the slag.



Pouring. (Courtesy The Midvale Company)

It has been found by Pukall[8] that when silica in a finely divided condition is heated with aluminum fluoride alone or with an alkali chloride, SiF_4 is formed and also an aluminum silicate in the first case, and an aluminum alkali silicate in the second. When an aluminum silicate is used instead of the silica, a similar reaction takes place, a compound richer in aluminum and poorer in silicon being formed. The reaction is general for silicates and takes place at moderate temperatures, below 1000°C.

Herty and coworkers[10] have shown that in melts of lime, silica and calcium fluoride, the last two decrease while the lime increases in such proportions as would correspond to the escape of silicon tetrafluoride, according to the equation previously given:

$$2CaF_2 + SiO_2 = 2CaO + SiF_4.$$

Dauvalter[11] states that it is probable that during the melting of glass, SiF_4 is evolved and is subsequently decomposed in contact with water vapor into SiO_2 and HF. He further suggests that the highly corrosive action on glass pots of melts containing fluorine and the fact that in the glass the silica content is higher and the alumina lower than in the grog of the pot support the view that AlF_3 is formed with subsequent formation of SiF_4, according to the reaction:

$$4AlF_3 + 3SiO_2 = 2Al_2O_3 + 3SiF_4.$$

On the other hand, loss of fluorine from glass occurs through volatilization of the added fluorides, especially NaF and AlF_3, rather than through the formation and volatilization of SiF_4, according to Agde, Krause and Lehmann.[12]

As to volatilization in the form of molecular fluorine, the evidence makes it appear to be unlikely. Jellinek and Rudat[13] give the fluorine tensions of the fluorides of Pb, Ni, Co, Fe, Cd, Zn, and Cr between about 280° and 840°C. The corresponding vapor pressures lie between 10^{-54} and 10^{-24} atmosphere. These values are taken from a graph on which the negative logarithm of the partial pressure of fluorine as ordinate is plotted against the reciprocal of the temperature as abscissa. The curves for the fluorides of the metals mentioned are straight lines practically parallel to each other, with the exception of ZnF_2, which has a steeper slope than the others. The fluorine tensions of the higher fluorides are slightly higher than those of the lower ones; for example, FeF_3 as compared with FeF_2. If these curves may be extrapolated without great error to temperatures such as are met in open-hearth practice, the vapor pressures would still be so low that the loss of fluorine in this manner by such of these fluorides as might be present would be inappreciable.

There is some evidence that sublimation of undecomposed fluorides may take place. Besides the volatilization of NaF and AlF_3 from glasses and enamels already referred to, Hofman[14] states that some of the solid fluorides which are readily fusible are volatilized without decomposition (SbF_3, AsF_5, CrF_3, HgF_2, SnF_4, ZnF_2 . . . .). It is possible that MoF_4, which melts at 98°C., may be volatile at temperatures about 1500° higher, such as are employed in steel-making processes. The presence of such fluorides might result from the reaction of fluorspar with the metals alloyed with iron and steel. However, calcium fluoride itself is not appreciably volatile at steel-making temperatures. In an experiment made by the present writer, pure CaF_2 held molten at 1600°C. for one hour in an open graphite crucible lost less than 0.2% by weight.

There are several fluorides of non-metals which are volatile. Under reducing conditions CF_4 which boils at −130°C. (Klemm and Henkel[15]), might be formed, but there is evidence that it is more likely to exist at low rather than high temperatures. Fluorine oxide has been investigated by von Wartenberg[16] who reports its heat of formation as −9,000 cal. Since this is an endothermic reaction which would presumably be favored by the high temperatures and oxidizing conditions in the basic open-hearth furnace and since the product we are concerned with is a gas, it is possible that fluorine leaves the slag in this manner.

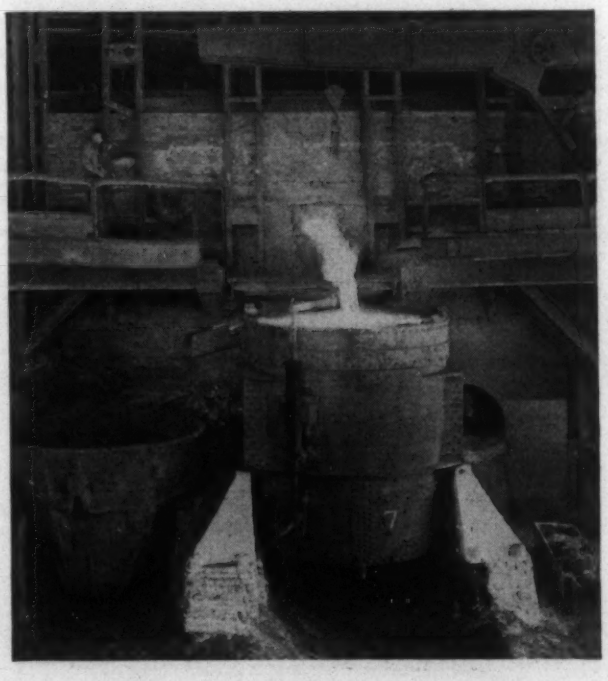
The formation and volatilization of a sulphur fluoride from basic slags is quite well established. Fischer and Jaenckner[17] have investigated the compound, sulphur tetrafluoride. They found that a mixture of CoF_3 and S decomposes at room temperature with a disagreeable odor. Slight heating or use of large quantities in a closed apparatus causes an explosion and deflagration. Dilution

with fluorspar avoids this danger. The equation for the reaction is mainly

$$4CoF_3 + S = 4CoF_2 + SF_4.$$

The SF_4 is colorless and distills between $-120°$ and $-90°$C. A higher fluoride of sulphur, SF_6, is also known.[15] Apparently the best evidence of the volatilization of fluorine as a sulphur fluorine compound from basic open-hearth slags may be found in the work of Schleicher[5] previously cited. This will be discussed later under desulphurization.

Concerning the amount of fluorine left in basic slags there is a great diversity of opinion. There are some writers who report that all the fluorine is eliminated. Thus, Geiger[9] states that basic open-hearth tapping slags do not contain fluorine. He gives the analyses of 5 basic open-hearth tapping slags in none of which was any fluorine reported "and yet in one of them, No. 1, 1250 lbs. of spar was added to the slag, which weighed (actual weight) 27,600 lbs. Under these conditions at least 2.0% fluorine should be present, but none was found, very careful analysis of all possible ingredients totaling 99.89%." Similarly, Deurvorst[18] and Wilke-Dörfut and Klingenstein[19] state that when fluorspar is added to the charge of a cupola furnace, the slag contains no fluorine. On the other hand, Moldenke,[19] commenting on the findings of the writers last mentioned, says that "in open-hearth practice . . . up to 2.5% calcium fluoride has been found in slags when fluorspar was used for thinning down the slag." Schleicher[5] found from many basic open-hearth heats, low in manganese and high in sulphur, to which fluorspar had been added for the purpose of desulphurization, that the tapping slags quite uniformly contained from 2 to 2.5% calcium fluoride. He found that although the immediate effect of adding fluorspar is to render the slag more basic by volatilizing some of the silica as silicon tetrafluoride, in a few minutes the silica will be replaced. Commenting on Schleicher's experiments Ladoo[3] is mistaken in saying, "His conclusions regarding silica can only apply, of course, when an acid (silica) lining is used in the furnace, and not in the basic open-hearth process." He was evidently misled into believing that the hearth consisted of silica by the fact that the slag takes up silica from the hearth to replenish itself. Schleicher explained in the discussion on his paper that the source of the silica is the slag which saturates the dolomite hearth. The slags on which he bases his conclusions and of which he gives the analyses contained from 35.5 to 45.9% CaO and from 15.2 to 19.6% SiO_2. These are quite typical basic open-hearth slags. Another source of silica may be the upper side walls and roof of silica brick, which sweat and run down at high temperatures. Interpreting Schleicher's conclusions Ladoo is inaccurate in writing, "If fluorspar is added to an open-hearth slag it is only decomposed and reduced to a certain extent, namely 2 to 2½% of the CaF_2 content." Schleicher says, and illustrates with analyses, that the final calcium fluoride content is 2 to 2½%.



Tapping. (Courtesy Bethlehem Steel Company)

Discussing the restricted use of fluorspar in open-hearth practice, Goldmann[20] says, "The reason for these small additions was perhaps principally the fear of the corrosion of the hearth lining. This evil can, however, be quite well met by carefully patching with dolomite. In the above, however, the disadvantage of the use of fluorspar has perhaps been over emphasized; while on the other hand the great advantages have not been sufficiently appreciated. In the open-hearth practice carried out by me at the Falva works, with many heats, 1000 kg. and more of fluorspar were used without a noteworthy damage to the furnace being perceptible." Schleicher[5] also says, "I have never been able to observe a strong attack on the roof. Even with the addition of fluorspar to every single heat during an entire campaign no shorter life of the furnace roof could be determined than by operation without fluorspar; however, the hearth suffers and the consumption of dolomite increases." Concerning operations at Duisberg, Germany, Donner[5] says, "We have never been able to determine that the furnace lining is attacked or destroyed through the addition of fluorspar, assuming that the fluorspar is added in the correct manner." Referring to the influence of fluorspar on the corrosion of the silica brick roof of the basic electric furnace, Sisco[6] says that "it is doubtful whether corrosion of the refractories results in their earlier failure. Lining and roof nearly always fail through cracking caused by uneven expansion and contraction. The corrosion of fluorine is evenly distributed."

Sisco[6] gives the analyses of 8 basic electric deoxidizing white slags, some of them showing a considerable calcium fluoride content, one as high as 36.83%. Within an hour, however, this had dropped to 19.13% and was 8.61% after another hour. In the meantime, various additions of slag-making materials had been added. The presence of large proportions of fluorspar in such slags may be accounted for by the fact that they are usually more strongly basic than other slags, so that more fluorspar may be used as a thinning agent, and possibly being lower in silica, with no strong stream of gas passing over the bath to facilitate the removal of silicon tetrafluoride as would be the case in basic open-hearth furnaces, the residual fluoride content of such slags might be expected to be higher. Sisco looks at the matter from another angle, however: "The error in the regular analysis of electric furnace final slags is not only in the calculation of all the calcium fluoride to the oxide (when in truth it exists not only as the oxide [silicate] but also as either the fluoride or fluosilicate) but also in the silica. Any silica present as calcium silicate will be obtained by analysis by the regular method. Any silica existing in the slag as a fluosilicate will be volatilized and lost if the slag is analysed by standard methods. It goes off as silicon tetrafluoride when acid is added to the slag or to an alkali fusion of the slag." For a long time it has been recognized that existing methods of chemical analysis for silica and fluorine in the presence of each other have been unsatisfactory. Evidence of this is the number of improvements which have been suggested in the literature during the past decade. The researches of Lundell and Hoffman have culminated in a method which is probably the most

accurate and up-to-date, described in their recent book.[21]

That all of the fluorine is not volatilized from glasses and enamels is mentioned by numerous writers. Thus, Wilcox and Westendick[22] state that the duration of smelting and the viscosity of the smelt affect the amount driven off. The higher the Al_2O_3 content, the less the loss of fluorine. These facts were determined from analyses of enamels of various compositions melted for varying lengths of time. Dauvalter[23] in analyzing milk glasses of different compositions also observed a more or less constant relationship between the fluorine and the aluminum according to the formula AlF_3. He attributes the corrosive action of glasses containing fluorine on fusing tanks to the conversion of Al_2O_3 in the grog and "glazing" layer into AlF_3, the volatilization of fluorine occurring slowly and the greater part remaining in the glass. The attack may also be explained by the fact that the refractory Al_2O_3 is being converted into a low-melting compound; AlF_3 melts at about 1040°C. Of course it would be expected that differences regarding fluorine would be found when comparing glasses and enamels on the one hand and slags on the other because of differences in composition and the greater temperature at which slags are worked.

Effect of Fluorspar on the Viscosity

It is well established that fluorspar does lower the viscosity of basic slags. Camp and Francis[24] say, "For the purpose of making slags more fusible without changing their acidity or basicity, neutral substances having very low fusion points may be used. This practice is common in basic open-hearths. Fluorspar is the substance generally used." Fluorspar is also listed as a neutral flux by Stoughton and Butts[25] and Rosenholtz.[26] The latter says, "Fluorspar, CaF_2, is often used as a flux for the sole purpose of increasing the fluidity of the slag. It is a neutral compound and, as a result, does not affect either the acidity or basicity of the slag." Contrast the above with the statement by Sisco[6] that, "Fluorine affects the slag by increasing its fluidity and indirectly *de*creasing its basicity," bearing in mind that he is referring to the basic electric process. It seems probable that this is a typographical error and that he believes that fluorspar indirectly increases the basicity, because he also says, "It is neither acid nor basic in itself, although it breaks up into lime and thus becomes a base after being acted upon by the arc." Moreover, he presents equations showing the step-wise reactions of CaF_2 with SiO_2 in the slag, which add up to the following:

$$2CaF_2 + SiO_2 = 2CaO + SiF_4.$$

His analyses of basic electric furnace white slags, previously referred to, show that the silica bears an inverse relation to the amount of calcium fluoride present. This may be accounted for by the evolution of SiF_4 as previously discussed.

Although the primary effect of fluorspar is to lower the viscosity, in several instances of cupola furnace operation the use of excessive quantities of fluorspar has caused secondary effects to mask the primary one. F. B. M. Deurvorst[18] states that partial replacement of "Hardstone" (a variety of limestone containing CaO 52.7%, Al_2O_3 2.1% and Fe_2O_3 1.2%) by fluorspar does not affect the melting process, although a slight attack of the furnace lining is noticeable. D. Deuvorst[27] states that the same is true when limestone is partly replaced by fluorspar, but the slag is much more fluid than a lime slag and the loss of Si, Mn and the absorption of S are not influenced.

Similarly, Wilke-Dörfut and Klingenstein[19] reach the conclusion that, "A cupola slag obtained with admixture of fluorspar to the limestone used, is more viscid and less basic than when limestone of a high purity is used alone. This, because the silica and alumina content have been raised and the fluorine volatilized before the final stage of the slag formation has been reached." Their experiments were made using pure limestone and fluorspar, varying the relative quantities of each. The proportions were as follows: limestone alone, 1 CaF_2 : 3 $CaCO_3$, 1 : 2, 2 : 1, and fluorspar alone. These experiments showed that increasing the ratio of fluorspar to limestone in the charge decreased the percentage of lime in the slag, while the yield of slag increased, indicating that the lining of the cupola had been attacked. Naturally, with the decreased basicity of the slag there was a lack of desulphurization. As to fluidity of the slag, further investigation showed that undoubtedly the slag when first made was thinner, but as it attacked the lining the character changed, and eventually the slag came from the cupola just as viscid as if the fluorspar had not been used at all. Further tests on melting and softening points of the slags made with and without fluorspar verified this conclusion. However, none of the slags, even those with all fluorspar fluxing, was found to contain any fluorine, showing apparently that this had been volatilized during the melting operation.

Teeming. (Courtesy Timken Steel & Tube Company)

A rejoinder to this article was made by Osann.[7] He stated that the poor desulphurization was due to the use of excessive amounts of fluorspar, for good results were obtained with a flux of two-thirds limestone and one-third fluorspar. This seems to be the upper limit of practice in Germany, above which excessive cutting of the cupola lining would introduce enough alumina and silica into the slag to make it thick and less able to take up sulphur. In the United States the amount of fluorspar in cupola fluxing is much less, seldom exceeding 10%.

He states further that it is not necessary to prove that fluorspar thins the cupola slag when correctly used, as this is well known. In another article[28] he states that the correct proportion of fluorspar is reached when the quantities of fluorspar and limestone added are 7 and 14%, respectively, of the quantity of coke. He adds that the addition of fluorspar diminishes the quantity of slag and decreases the consumption of coke. Apfelböck[29] corroborates this, saying that fluorspar causes a smooth, clean and undisturbed working of the furnace and forehearth. Furthermore, the furnace has higher melting capacity. Fluorspar causes a diminution of oxidation and an increased desulphurization of the iron. Kirk[30] also says, "Fluorspar, when used in sufficient quantities, produces a very fluid slag that absorbs and liquefies the non-

metallic residue of melting with which it comes in contact, keeps the cupola open and working freely, and causes it to dump clean. . . . Fluorspar greatly increases the efficiency of a poor limestone and often enables a founder to use a cheap limestone that could not be employed alone as a flux. . . . We have used fluorspar in a number of cupolas and with a great many different brands of iron. . . . It improved the melting very materially in a number of cases where the cupola was run beyond its capacity."

Fohs[1] also has written, "The objections that have arisen in some quarters to the use of fluorspar in foundry practice are due to the ignorance of its capabilities and manner of use. . . . When it has been used in conjunction with limestone the failures have been due to an insufficient amount of total flux, usually with the additional error of an improper proportion of fluorspar and limestone in the mixture. . . . If no pure limestone is available (for the cupola charge), then dolomite is used, and in conjunction with this fluorspar is indispensable. . . . A typical practice in this respect is that of the Crane Co., Chicago, which, after repeated attempts to get pure limestone for flux, settled upon the use of fluorspar and dolomite."

It is important to consider how fluorspar increases the fluidity of a basic slag. Ladoo[3] quotes Howe to the effect that fluorspar acts as a catalytic agent. The idea is apparently due to Hamilton,[31] who says, "The remarkable fluidity conferred by a small amount of fluorspar being added to a molten slag has suggested to me that the reaction may be a catalytic one; i.e., the fluorspar may be only an agent." He suggests the following equations:

$$3SiO_2 + 2CaF_2 = SiF_4 + 2CaSiO_3$$
$$3CaO + SiF_4 = 2CaF_2 + CaSiO_3.$$

He explains, "Part of the silicon fluoride will escape but a greater part will react with the lime. . . . and the circle is repeated until all the silicon fluoride gas has escaped. In each reaction some silicate of calcium is formed, which is a slag of low melting point, and the fluorspar has only been an agent to unite the silica and lime, either of which alone is fused with difficulty." This does not explain, however, how the viscosity is decreased by fluorspar if the lime and silica have already combined. In the experiments of Herty and Coworkers[10] the viscosity of mixtures of lime, silica and fluorspar was determined after crushing and melting 3 times, yet for a particular ratio of lime to silica the fluidity was found to be a function of the amount of fluorspar added. Also, Herty and Coworkers[33] have found that the presence of eutectics has no effect on viscosity in the lime-silica system. This is confirmed by the investigations of McCaffery and Coworkers.[34]

Hofman[14] suggests that "Fluorspar, which melts at 1378°C., is very fluid when melted and assists in dissolving refractory slag constituents. With $CaSiO_3$, e.g., melting at 1501°C.,* it forms a eutectic with 38.2% CaF_2 freezing at 1130°C. (Karandief, Zeitschrift für anorganische Chemie, Vol. 68, 1910, page 188.)" Much the same idea is expressed by Fulton,[35] who says that molten fluorspar is very thinly fluid and capable of holding in fluid suspension considerable amounts of non-fusible oxides. With this line of thought it is interesting to note that calcium fluoride and magnesium fluoride form a eutectic melting at 948°C. containing 40.3% MgF_2, while calcium fluoride and aluminum fluoride form a eutectic melting at 820°C. containing 60.8% CaF_2. The present writer has converted the mol percentages given in the Tables[36] into weight percentages.

*Later investigators place this temperature at 1540°C.

Pouring a Sample Ingot for the Laboratory
(Courtesy The Midvale Company)

Osann[7] suggests that the question of fluidity is one of mixtures of component parts, and a very small percentage of one material may have far-reaching consequences on the product. Discussing the effect of a small change in oxide composition on the mineral composition of silica-alumina-lime-magnesia slag, McCaffery, Osterle and Schapiro[37] have shown that in certain ranges of chemical composition a small change of only 1% makes a very considerable change in the percentage of compounds present. For example, a slag of the following composition:

SiO_2	32%	contains mineral compounds	Gehlenite	64.35%
Al_2O_3	24%		Anorthite	0.19%
CaO	43%		Calcium bisilicate	28.68%
MgO	1%		Akermanite	6.76%

If the lime is increased 1% and the silica decreased 1%, the slag contains

SiO_2	31%	and consists of	Gehlenite	64.55%
Al_2O_3	24%		Tricalcium disilicate	9.49%
CaO	44%		Calcium bisilicate	19.08%
MgO	1%		Akermanite	6.76%

Also in this connection the work of McCaffery and Coworkers[34] is especially significant. From measurements of the viscosities of lime-alumina-magnesia-silica slags they found that viscosity is not dependent upon the basicity in the sense in which that term is used to denote the ratio between the number of atoms of oxygen in the bases to the number in the acids, but upon the composition that determines the mineral composition as represented by the quarternary phase equilibrium diagram. Thus, McCaffery and Stephenson[38] say, "It has been shown that blast-furnace slags are not composed of oxides, as reported by chemical analysis, but are actually composed of several compounds, each made up of two or more of the oxides present. These compounds persist in the liquid state, and the properties of a slag are the properties of a mixture of the compounds, and not of a mixture of the ultimate oxides." For example,[34] it is found that a slag of the chemical composition CaO 45.38%, MgO 2.96%, Al_2O_3 7.44% and SiO_2 44.23%, whose mineral composition consists of akermanite 20%, calcium bisilicate 60% and gehlenite 20%, has a viscosity of 4.07 poises at 1500°C., while a more basic slag containing CaO 48.72%, MgO 7.40%, Al_2O_3 6.15% and SiO_2 37.73%, having a mineral composition of akermanite 50.08%, calcium bisilicate 5.83%, calcium orthosilicate 27.59% and gehlenite 16.53%, has a lower viscosity, 2.40 poises, at the same temperature. It should be pointed out, however, that one may not generalize from this that change of basicity has such and such an effect upon the viscosity, for with a slag whose composition places it in another part of the quarternary equilibrium diagram, reference must be made to the viscosity data to determine its properties.

Osann[7] believes that in the reaction

$$2CaF_2 + SiO_2 = 2CaO + SiF_4$$

the CaO may be in the nascent state and hence acting

very powerfully on any surplus silica remaining behind.

Geiger[9] has considered the problem at some length; the most significant part of his remarks follows: "If CaF_2 has any breaking down action on the mono-silicate of calcium, $(CaO)_2 \cdot SiO_2$, it would not have a tendency to form a more fusible higher silicate if part of the silica is removed as a volatile compound. On the contrary, it would have a tendency to form a lower, more viscous silicate, the subsilicate of lime, $(CaO)_3 \cdot SiO_2$, because of (1) increasing the CaO content of the slag from the calcium of the spar, and (2) by decreasing the SiO_2 as SiF_4 which must pass out in the waste gases, also increasing the concentration of CaO. The result would be a momentary thickening of the slag. This part of the function of spar is contradictory to general belief.

"There is one possible action that would contribute to making a thinner slag under the above assumed condition (increasing the lime content and decreasing the silica): reactions would take place as previously mentioned which would tend to re-establish the chemical equilibrium of the slag by the absorbing of available substitutes from the bath. Since the subsilicate of lime, $(CaO)_3 \cdot SiO_2$, is not likely to be formed from the freed CaO and the existing monosilicate, $(CaO)_2 \cdot SiO_2$, under the temperature and chemical conditions of these slags, the more readily formed $N \cdot CaO \cdot Fe_2O_3$ will likely be produced, partly because of the great ease of formation of this compound under the existing temperature and oxidizing conditions, and also because of the concentration of the Fe in the bath. This compound of $N \cdot CaO \cdot Fe_2O_3$ very probably imparts a greater fluidity to the slag than the $(CaO) \cdot SiO_2$ which is replaced. There will also be a certain amount of FeO formed. This addition of FeO and Fe_2O_3 replacing the lost SiO_2, re-establishes the constant value $SiO_2 + Fe = 32$ (which Geiger has noted from an examination of the analyses of some basic open-hearth tapping slags), and in so doing probably gives the slag a slightly increased fluidity.

"If the above analysis of the behavior of spar in basic slags is correct, iron oxide is the actual thinning agent, spar acting indirectly as the medium for setting up an unstable condition of the slag which could be neutralized only by the addition of iron oxide obtained from the bath."

An important objection to the foregoing hypothesis is that calcium fluoride thins white slags in the basic electric furnace and these are practically free from iron oxides. Nor is the consideration of viscosity of basic open-hearth slag as related to composition nearly as simple as Geiger's discussion suggests. In addition to the components lime, silica and iron oxides that he discusses there is always present some magnesia and alumina, and also varying amounts of oxides of manganese and phosphorus. We have already seen that even small changes in composition may affect considerably the properties of slags. Also, Herty and Coworkers[10] have investigated the temperature-viscosity relations in the system $CaO\text{-}SiO_2\text{-}CaF_2$ and have shown that as little as 5% CaF_2 added to $CaO\text{-}SiO_2$ melts was sufficient to lower the viscosities 50 to 75%, and this was in the absence of iron oxides. They suggest two possible explanations for the fluidifying effect of fluorspar on basic open-hearth slags:

a. decreasing the intermolecular cohesive forces

b. the breaking up of molecular aggregates.

It is evident that this problem deserves further attention. The confused state of our knowledge of this subject has led the present writer to undertake an extensive investigation of the effect of fluorspar on basic slags, experiments being in progress at the present time.

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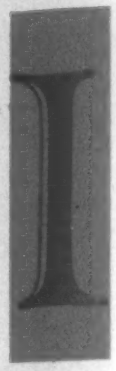
[37]R. S. McCaffery, J. F. Oesterle & L. Schapiro. Composition of Iron Blast Furnace Slags. *American Institute of Mining and Metallurgical Engineers, Technical Publication* No. 19, 1927, 42 pages.

[38]R. S. McCaffery & R. G. Stephenson. A Statistical Analysis of Blast-furnace Data. *American Institute of Mining and Metallurgical Engineers, Technical Publication* No. 384, 1931, 13 pages. *Transactions, Iron & Steel Division,* Vol. 95, 1931, pages 60-71.

(Part II will appear in the next issue)

RAPID DEVELOPMENT of PATINA on Copper after Installation

by John R. Freeman, Jr.† and Philip H. Kirby‡



The first stage in the development of patina by spray process.

IN A PREVIOUS paper of a similar title by the authors[1] a process was described for producing rapidly on copper the jade-green coloring or patina that forms after copper is exposed to natural weathering for a number of years. The patina was produced by a process of alternate immersion of the copper sample to be colored in a 10% ammonium sulphate solution, adjusted or "conditioned" to a definite hydrogen ion concentration. The patina obtained was a basic sulphate of copper, identical in composition with the patina that forms under natural weathering. The process was developed primarily for spandrels and other copper shapes used in building construction, in particular shapes not requiring forming or extensive soldering operations during installation.

There has always been a demand for a satisfactory method of coloring copper after installation particularly copper roofing of various types. The patina developed by the alternate immersion process while sufficiently adherent for ordinary handling will, like natural patina, flake off on severe bending. This is, of course, objectionable on roofing where bending is necessary for forming seams. The patina is also destroyed by heating incident to soldering.

The investigation was therefore continued with the objective of adapting the ammonium sulphate treatment to the coloring of copper after installation.

A successful technique has been developed whereby copper roofs may be given a "natural" patina by a simple spraying treatment.

Experimental Development of Coloring Process

The method of application of the ammonium sulphate solution has been found to be of greatest importance. It was known from the earlier work that maintaining a thin film of the "conditioned" ammonium sulphate solution in contact with the copper surface would produce the basic sulphate. Spraying, swabbing or brushing the solution on a copper roof suggested themselves. Swabbing was first tried as a convenient practical method of application of the solution. This, however, was unsuccessful due apparently to the repeated rubbing of the surface removing or destroying the adherence of the patina as it formed. Spraying was therefore tried, the surface being kept constantly moistened by repeated application. Color developed gradually similar to that obtained by the alternate immersion method. Irregularities in the surface however caused the solution to be distributed more or less unevenly causing varying depths of coloring and in some cases streaking.

A light sand blasting of the surface was found particularly helpful, the roughened surface retaining the solution better. It is of interest to note that the sand blasting indented rather than cut the surface of the copper.

A section of a standing seam copper roof which had been in place about 7 months was given a light sand blast and treated by repeated spraying, the surface being wetted down at about 10 minute intervals permitting partial to complete intermediate drying. A total of 20 applications of the solution was made after which a pleasing uniform color had developed.

Simultaneously with the above treatment an adjacent strip of roof was similarly treated, excepting this test strip was not sand blasted nor otherwise treated in any manner prior to spraying with the ammonium sulphate solution. The copper had a dark brown tarnish from the natural weathering of about 7 months exposure. This strip also developed a pleasing patina although somewhat less uniform than that on the sand blasted surface.

The color in both instances was considered somewhat too deep or intense, lacking the artistic variation of natural weathered patina. Tests were therefore made to determine the optimum number of sprayings required to produce the most pleasing results. A study was also made of the effect of intermediate drying between applications of the solution.

When but relatively few applications of the ammonium sulphate spray were made color was not apparent on completion of the spraying but, somewhat surprisingly at first, a very fine patina developed after the treated surface had been subjected to rain. Attempts to hasten the development of the color by washing or spraying with clear water after treatment were unsuccessful, except when the treated surface was permitted to remain over night before washing with water. Samples similarly treated but kept in the laboratory did not develop color on subsequent washing regardless of the time interval. These first tests were made during the summer months when there was a dew fall practically every night. It was evident that this precipitation of dew on the treated surface, which occurred out of doors but not in the laboratory, provided moisture which promoted a chemical action on the copper which was essential for color to develop on subsequent washing either by spraying or rainfall.

The hygroscopic properties of ammonium sulphate were known. To understand better the nature of the reaction tests were made under controlled conditions. Specimens treated in the usual manner by spraying with intermedi-

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*The work reported here was carried out in the laboratories of The American Brass Company under the direction of Mr. W. H. Bassett.

†Technical Department, The Amercian Brass Co.

‡Copper and Brass Research Association.

[1]*Metals & Alloys*, Vol. 3, Sept. 1932, pages 190-194.

ate drying were placed in atmospheres of known relative humidity varying from a minimum of about 30% to practically 100%. These tests showed conclusively that for the chemical attack to proceed for proper development of color, a relative humidity of at least 75%, preferably about 80%, at normal atmospheric temperature, is required, and that the treated material should be exposed to this humidity for a period of at least 3 hours before washing by spray or rain.

These requirements may appear at first rather limiting in practical application where the vagaries of the weather must be depended upon. It is obvious, however, that a dew fall or fog provide ideal conditions of high humidity. The former is an almost nightly occurrence in summer weather. On overcast days the relative humidity is high and always preceding a rain the relative humidity may be high over relatively long periods prior to the actual fall of rain, except, of course, with sudden summer showers.

Procedure for Coloring*

Based on the experimental studies the following procedure has been developed which has proved very satisfactory. It is given in sufficient detail here that it may be tried by anyone interested:

Materials Required

The following amounts will make about 110 gallons of solution. Proportionate amounts should be used for small quantities. *All measurements must be exact.*

90 lbs. Ammonium Sulphate—Technical Grade. (Agricultural grade may be used but its use requires filtering of solution because of contained dirt.)

3 lbs. Crystallized Copper Sulphate (Blue vitriol).

1 lb. 3 oz. Concentrated Ammonia (specific gravity 0.90). This is equivalent to 21.1 fluid ounces.

100 gallons clear water.

*United States Patent No. 1,951,304 and Canadian patent No. 334,996 have been allowed covering this process and are controlled by the Copper and Brass Research Association.

Copper Spandrel by Intermittent Immersion Method

Preparation of Solution

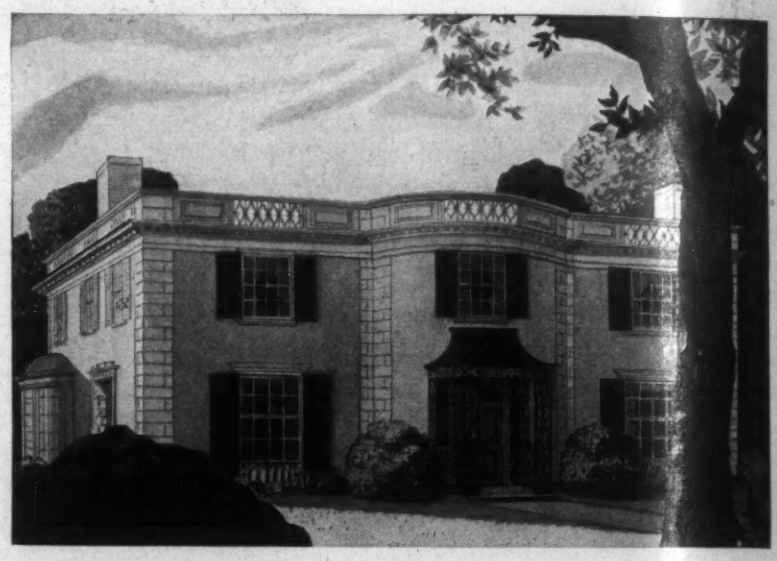
IMPORTANT: No iron or metal containers except lead should be used for preparing or storing solution. Wooden barrels or tubs are satisfactory.

Dissolve the 90 lbs. of ammonium sulphate in the 100 gallons of clear water. Solution should be complete.

Then add the 3 lbs. of copper sulphate to the above solution of ammonium sulphate. This is best done by removing a few gallons of the above solution and dissolving in it as much of the copper sulphate as possible, returning this to the original volume. Repeat this procedure until all of the copper sulphate is dissolved.

Then add *slowly* with *constant stirring* the 1 lb. 3 oz. (21.1 fluid ounces) of concentrated ammonia to the above solution of ammonium sulphate and copper sulphate.

It is *especially important* that the ammonia be measured exactly. (The ratio of 1 lb. 3 oz. of ammonia to 100 gallons of water *must* be maintained in preparing this and smaller or greater amounts.)



"House of Years" (W. & J. Sloane, New York City).
Copper canopy over front entrance and copper roof over bay window colored by the Cabra ammonium sulphate syray process.

Method of Application

The copper surface to be colored should be free from oil and grease and any accumulation of dirt incident to installation. This can be accomplished readily by washing with alkali, such as sodium carbonate solution, or lye, followed by washing with clear water to remove the alkali. The copper should then preferably weather for a few days to develop a brown tarnish. The adherence of the patina appears to be better when applied to a tarnished surface than if developed on a polished or bright pickled surface. The time will, of course, depend upon conditions, but 2 or 3 rainstorms have proved adequate. The rain also helps to remove traces of the alkali cleaning solution.

The solution is applied by spraying. An ordinary knapsack garden sprayer as used for insecticides, the inside of which is coated with bituminous paint, has proved very satisfactory.

The spray should be applied rapidly and in such manner that, after spraying, the solution rests on the copper surface in isolated droplets. This can be readily accomplished with a little practice. It is better to apply too little than too much since with an excess large drops tend to accumulate and will run down over the surface and may cause streaks.

Five sprayings have been found adequate. Between each spraying sufficient time should be allowed to permit drying. This will depend upon weather conditions. On a warm sunny day 10 to 15 minutes is sufficient; on cloudy days a longer period is obviously required. Areas in heavy shadow or

sheltered from wind will also require a somewhat longer drying period. Upon completion of the 5 applications the copper surface should be coated with a thin "glassy" (appearing) film of the deposited salt. Color may not be apparent, as it develops more or less gradually, although when application is made on humid days or in shaded areas, where drying is slow, appreciable color may be apparent before all applications have been completed.

The ideal conditions are a sunny day followed by a moderate to heavy dew or a "dripping" fog. With these conditions the color will appear in a few hours.

The patina as it first develops has a bluish cast due probably to the presence of copper ammonium compounds. On weathering this disappears, the color approaching the jade-green of natural patina.

It should be stated that the above method has been applied using a simple ammonium sulphate solution instead of the "conditioned" solution. A satisfactory patina is obtained but it does not appear to have as good adherence as when the "conditioned" solution is used.

St. Paul's Lutheran Church, Corner Palmetto & Knickerbocker Aves., Brooklyn, New York.

Copper covered steeple colored by Cabra ammonium sulphate spray process. Steeple is about 65 ft. high and has about 1700 sq. ft. area. Coloring treatment applied about 10 days after laying of copper before removing scaffolding used in construction. Treatment required about one gallon of solution per 150 sq. ft. of surface. About 10 man-hours required for treatment.

The Nature of the Chemical Attack

The chemistry of this coloring process is undoubtedly similar to that described in the previous article, but in this case the reaction probably occurs by the action of oxygen concentration cells between the center and rim of the individual droplets during application. The action is probably more rapid under these conditions because of greater accessibility of the air at the edge of droplets than where the surface is completely covered with a film of moisture as in the alternate immersion process. After all spraying has been completed and action is continued by absorption of moisture due to hygroscopic nature of the salt, attack appears to occur principally around the edges of individual salt crystals. The odor of ammonia is noticeable at all times when the surface is moist, as was noted under the alternate immersion process.

Composition and Permanence of Patina

The compositions of some patinas as obtained by both the spray and alternate immersion methods are given in the table. There are also given the compositions of similar patinas after weathering under different conditions for various periods and for comparison the composition of a patina taken from a church steeple in Brooklyn, New York, on which the copper had been in place about 37 years.

It is evident that the synthetic patina is practically identical with patina formed by natural weathering. Comparing the Brooklyn, New York, sample with similar data given in the earlier work[1] it will be noted that the composition is very similar to that found for specimens from Providence, Rhode Island, New Haven and Waterbury, Connecticut. The almost complete absence of carbonate and chloride from the natural patina is noteworthy when compared to similar analyses reported by Vernon[2] on samples from several old copper roofs in Great Britain.

The changes that occur in the composition of the patina are of interest. There is a definite decrease in the ammonia content indicating its relation to the change from the blue shade to natural green, also the color that first appears when the spray technique is used is always of a lighter more natural shade than the color first obtained by the alternate immersion process and it is therefore of interest to note the marked difference in initial ammonia content of patina formed by the 2 methods.

The high chloride content of the sample exposed 21 months at the marine location may be due in part to wind borne salt, this location being a small island in Long Island Sound where in heavy storms the sea water spray is often carried across the island.

Several different applications by the spray method to exposed roofing were made during June and July 1933 on a 7 months old copper roof of The American Brass Company in Waterbury, Connecticut. After about 8 months exposure through the heat of summer and considerable severe winter weather the patina on the several test areas is in excellent condition and appears to have hardened and become more adherent than when first applied. A maximum temperature of 135° F. on the surface of the roof was recorded one day during spraying of a test section. Recently local air temperatures of —20° F. have been recorded. There have also been numerous snow and sleet storms.

Samples treated at a marine location are in good condition after 3 months exposure. Samples prepared by the alternate immersion process referred to in the earlier work have now been exposed at marine, industrial and rural locations for over 2½ years and are in excellent condition. The composition of the patina on a modern bronze statue has recently been reported by Gettens.[3] The statue has been exposed at Hartford, Connecticut, for about 38 years. The patina was found to consist mostly of basic copper sulphate corresponding approximately to the formula $3CuO.SO_3.2H_2O$, or antlerite, but containing a considerable amount of tin oxide. There is a demand for a method of the rapid development of patina on art and architectural bronzes. The ammonium sulphate process has been applied, but adherence is not so good as on pure copper. On alloys of higher zinc content, especially above 15 to 20%, the adherence is very poor. Studies are now being directed toward suitable modifications to adapt the process to copper alloys. Copper plating or slight dezincification of the surface to be colored have been found to be helpful.

Rate of Development of Natural Patina

It is of interest to record a few observations on the rate of formation of patina under natural weathering.

In 1921, Mr. W. H. Bassett, Metallurgical Manager of The American Brass Company, arranged for the exposure of samples of 9 types of electrolytic and fire-

[2] W. H. J. Vernon. Note on the Green Patina on Copper. *Journal Institute of Metals*, Vol. 52, No. 2, 1933, pages 93-100.

[3] Rutherford J. Gettens. *Technical Studies Field Fine Arts*, Vol. 2, No. 1, 1933, pages 31-33; *Chemical Abstracts*, Vol. 27, 1933, page 4514; *Institute of Metals, Metallurgical Abstracts*, Vol. 53, 1933, page 703.

Copper Spandrel by Intermittent Method

refined coppers at several locations representing various industrial, rural and marine atmospheres. In the course of years some of these were lost, but complete data are available on samples exposed in Kenosha, Wisconsin; Waterbury, Connecticut and Winchester, Connecticut.

The samples had all turned black after about 2 years exposure. There was then no further apparent change until 1932, after about 11 years exposure, when the samples at Kenosha were found to have developed a green coloration over the major portion. Where buckling had occurred, forming valleys which retained water, the color had not developed on the lower areas of these valleys. No color was apparent at the inspection about 1½ years previous.

The samples at Winchester, Connecticut, which is a quiet rural location, began to show color after about 12 years exposure and are now gradually approaching the natural shade.

The samples in Waterbury are just beginning to show color. These samples, however, were possibly influenced by sulphide fumes from the laboratory.

It is of interest to note that the type of copper had no significant bearing on the rate of patina formation.

The long period of weathering prior to first appearance of color is of interest, and of even greater interest is the relative rapidity with which the green patina develops once it has started. Similar "probationary" periods have been reported and discussed by Vernon and Whitby.[4]

[4]Vernon & Whitby. The Open Air Corrosion of Copper. *Journal Institute of Metals*, Vol. 42, No. 2, 1929, page 190.

In New York City the rate of development appears to be quite varied. The shortest period of exposure in which appreciable color developed that has been brought to the authors' attention is 5 years. This was on the copper coping of the "Park Lane." Copper on neighboring buildings is reported to have taken a longer period of time. General opinion indicates about 8 to 12 years as being required. The authors know of 3 church steeples in Brooklyn, New York, which are still black after 7 years exposure.

That the rate of coloring may be slow in some localities is indicated by copper sheet on a private residence near Garrison, New York, which is just showing color after more than 30 years exposure, although other, particularly older, portions have an unusually fine patina. This residence is on a high bluff about 800 feet above the Hudson River in a rural district across the river from West Point.

An unusual and rapid development of patina was observed on some test samples in the industrial atmosphere of Waterbury, Connecticut. Several sheets of copper were placed on a rack about a foot above the roof of a factory building and treated with solution to develop patina. The solution was not a very satisfactory one, but after 2 years exposure the under side of the sheets which had not been treated in any way were found to have developed a very fine patina. This was an early and definite indication of the marked influence of moisture on the rate of patina formation. It also suggested the possible influence of light, in particular direct sun light, as some copper salts are known to be photo sensitive.

Summary and Conclusions

A method is described for producing on copper after installation the jade-green patina which forms after several years exposure by natural weathering. The process consists essentially of 5 sprayings of the copper surface with a "conditioned" ammonium sulphate solution with intermediate drying. The patina formed is practically identical in composition with the natural patina, a basic sulphate of copper.

The process has been applied successfully to a 65 ft. copper covered church steeple in Brooklyn, New York, having about 1700 sq. ft. of surface, to a "copper-flex" roof and siding (about 700 ft. area) of a large porch of a private residence at Garrison, New York, to numerous smaller exhibit roofs and panels, as well as test panels at industrial, rural and marine locations.

The process is too new to have accumulated extensive exposure data on permanence. The maximum exposure to date is about 8 months in a severe industrial atmosphere and 3 months in marine atmosphere. These test exposures which have included hot summer as well as severe winter weather indicate that the patina increased in hardness and adherence with time.

Data are also given of observations on time required for patina to form under natural weathering.

Composition of Patinas after Exposure to Various Atmospheres.

	Spray Method		Alternate Immersion Method				
	About 2 weeks after color developed %	Industrial atmosphere for about 5 months %	Samples kept in laboratory %		Marine atmosphere 21 months %	Accelerated[4] industrial atmosphere 19 months %	Church steeple Brooklyn, N. Y. 37 years %
Copper	50.94	55.05	52.54[5]	54.40[6]	57.25[5]	55.55[6]	48.46
Sulphate	18.90	18.93	..	19.92	..	19.57	18.81
Hydroxyl	20.85	22.54	21.30	21.87	24.38	22.54	19.26
Ammonia	0.06	0.031	0.30	0.072	0.18	0.028	carbonate—none
Chloride	..	..	0.00	..	7.18	..	slight amount
Insoluble	3.18	..	..	..	..	..	13.0[3]
Moisture	2.34[1]	..	0.76[2]	..	0.82[2]	..	..

[1] 5 hours at 190°C. [2] Dried at 130°C. [3] Wind borne material and moisture. [4] Consisted of spraying the samples with water for about 5 min. 4 times daily. [5] and [6] The 2 samples marked 5 and 6 respectively are directly comparable, having been prepared at the same time under identical conditions.

Development of Adnic

A Corrosion and Heat-resisting White Metal Alloy

by William B. Price*

No. 3 in a series of Case Histories in Metallurgical Research

THIS is an account of the development of a special diaphragm alloy for thermostatic steam traps and similar devices. The work necessitated very close coöperation between engineering and metallurgical departments of the customer and the producer.

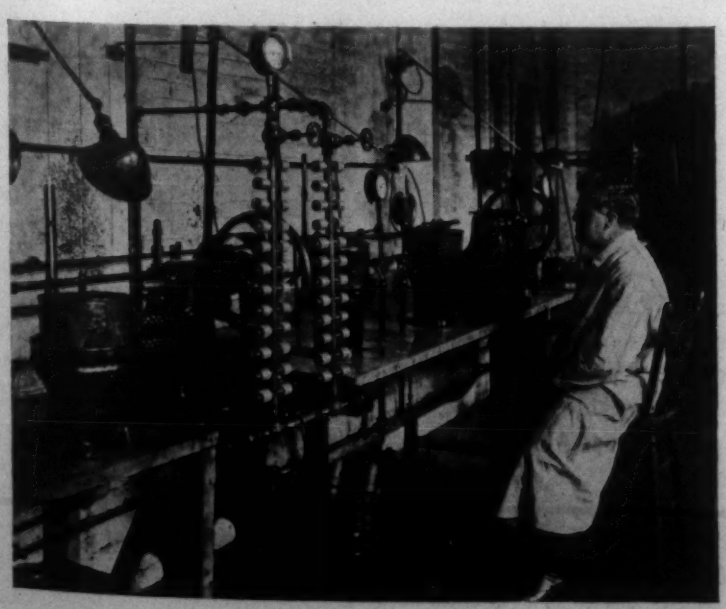
The problem consisted in the making of an alloy which, when rolled to a thickness of approximately .008″ would not crack, soften or stretch under repeated action at high temperatures.

The first step in development was undertaken by the customer, who tested all available alloys on the market that might be considered adaptable for the requirements. There seemed to be a wide variation in the performance of different lots of the same alloy, which could only be attributed to lack of necessary control in casting, rolling and heat treating of the metal.

The net result of tests of between 60 and 70 alloys indicated none as being entirely satisfactory or meeting the service requirements. The standard test consisted in making thermostats comprising 3 chambers or 6 single diaphragms. Sixteen samples were placed on a header and inserted in an oil bath, which was maintained at a temperature of 350°F. An air pressure of 30 lbs./in.^{2} expanded the thermostats at the rate of 70 operations per minute and upon release of the pressure, the thermostat was required to contract of its own metal tension.

Prior to insertion in the oil bath, each thermostat was measured for length and observations made as to the expansion at various pressures.

*Chief Chemist and Metallurgist, Scovill Manufacturing Company.



Testing the Diaphragms.

Three oil baths are shown in the illustration. Each contains a header, to which is attached 16 thermostats. Oil bath is maintained at a temperature of 350°F. Air under 30 lbs. pressure is admitted to the header and the thermostats are expanded to their full unrestricted travel. Relief valves are operated by a reciprocating device which opens and closes a valve leading to each header at the rate of 70 times per minute. Upon release of the air pressure from the header and thermostats, they contract into their original free length. With this method, the strains set up by expansion and contraction under temperature conditions can be studied. On the 2 vertical headers are thermostats which operate under room temperatures at the same rate as those in the oil bath. By comparing the results obtained with the 2 methods of testing, the effect of action at low temperature can be compared with similar action under high temperature. Thermostats are removed from the oil bath at intervals of 100,000 operations and observations made as to stretching pressures for different travels to determine whether there was any elongation of the thermostat and at half hour intervals, each oil bath is inspected for the purpose of determining whether any diaphragm has fractured, as evidenced by air bubbles escaping to the surface.

It might be pointed out that the softening effect, due to high temperature and action, creates a very undesirable condition in a commercial thermostat, for when the thermostatic fluid is inserted, a mixture and an amount is used which will maintain a saturated vapor throughout the entire range of operation and which also will have a pressure-temperature curve which is parallel to the steam curve.

If the initial charge is such that at a temperature of 212°F. and 0 lbs. gage internal fluid pressure of 30 lbs. will expand the thermostat so that the discharge port will be closed, any softening which occurs would result in a lower pressure necessary to expand the thermostat and instead of closing the port at 212°F. the same result might be obtained with a temperature of 195°F. If the thermostatic member is used as a control, for the port in a steam trap, premature closing, due to softening, would cause the holdup of condensation in the trap.

After checking the results of the first 100,000 operations, the thermostats were again placed in the oil bath and the operation continued up to 500,000 operations and thereafter, unless breakage occurred or softening was indicated, a check was made at the end of each 500,000 operations.

The net result of the tests of the various alloys indicated a wide variation. Some thermostats would fracture

before an opportunity was afforded for the first observation, while others in the same batch would show signs of softening. Then again, another alloy might show 50% breakage under 100,000 operations while the remainder might show several million operations without softening or breakage. Repetition of the test, using what was supposed to be the same alloy, showed entirely different results, and the conclusion was therefore reached that there was inadequate control over the handling of the alloys in the various processes up to the final rolling.

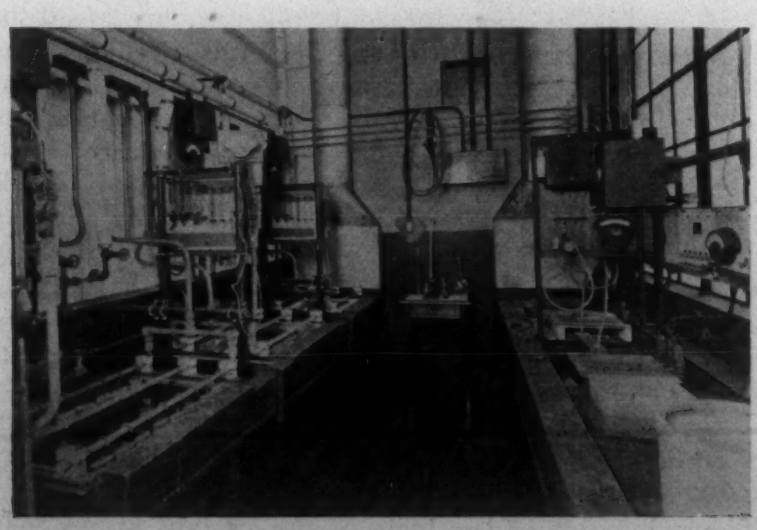
During this "cut and try" period, which extended over 2 years, the engineering department maintained a reasonably close contact with the metallurgists, primarily for getting comments on the various alloys, advice relative to the proper degree of hardness and to secure photo-micrographs of fractured diaphragms. After admitting that they had reached their limit, the engineers collected the results of their experiments and tests and turned them over to the metallurgist with the suggestion that a special alloy be developed to meet the exacting requirements. A study was made of the various tests and the alloys which gave the best results were segregated and again reclassified according to composition.

It appeared that alloys having compositions approximately that of Monel metal gave the best results, although in the engineer's tests, the results obtained from the latter metal were very irregular. Through this narrowing down process, various copper-nickel alloys were made up under very exacting laboratory control. Signs of improvement began to appear with alloys close to the commercial ones reported in the engineer's tests. This indicated that part of the problem could be solved with proper casting and rolling mill control. The final outcome of the metallurgist's work after approximately 6 months of experimental research was the development of Adnic. Patent application was filed February 15, 1923, and the patent[2] granted on April 28, 1925. This patent covers copper-nickel-tin alloys in which the percentage of the 3 elements copper, nickel and tin will not vary outside the following limits:

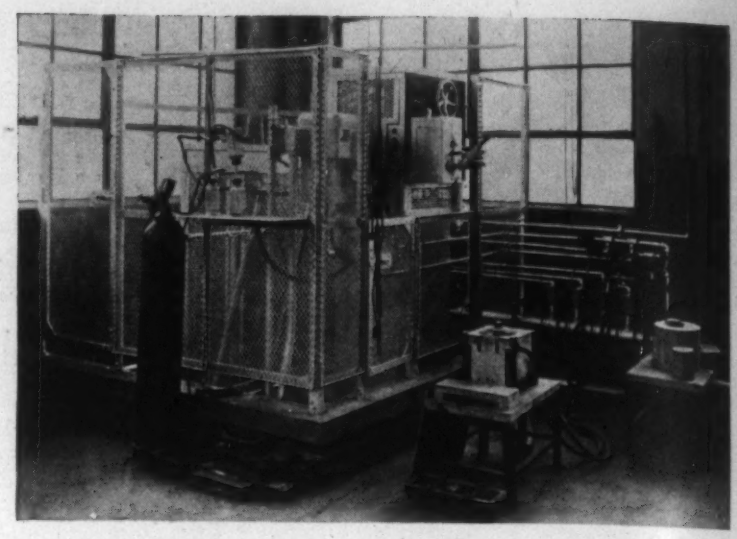
Copper	61.6-99.00%	Nickel	0.5-33.00%
	Tin	0.5-11.90%	

This alloy was first described by the writer in a written discussion in connection with the Symposium on Corrosion-resistant Alloys at Atlantic City, 1924.[1]

"Adnic" is an abbreviation from Admiralty nickel, the proportion of copper and tin being the same as in regular Admiralty condenser metal, with 29% nickel replacing the same percentage of zinc. The composition of the alloy is 70% copper, 29% nickel and 1% tin.



The Laboratory Plating Room.



High Frequency Furnace for Experimental Melts.

The preliminary work in connection with the development of Adnic was started by casting 4 binary copper-nickel alloys of the following composition:

Alloys Used in Developing Adnic

No.	% Copper	% Nickel
A	90	10
B	80	20
C	70	30
D	60	40

Various amounts of tin were added to each of these mixtures to produce a series of ternary copper-nickel-tin alloys. The 70% copper, 30% nickel binary base proved to be the most suitable as a starting point and the addition of 1% tin produced the ideal ternary copper-nickel-tin alloy (copper 70%, nickel 29%, tin 1%) for diaphragms. A complete account of this procedure was described in a paper by the writer and associates, "Alpha Phase Boundary of the Copper-Nickel-Tin System."[3] The physical properties of Adnic at ordinary and elevated temperatures were given in *Mining & Metallurgy*, November 1927 issue.[4]

In making the alloy on a commercial basis, it was found that the same exacting control was necessary in the casting shop and rolling mill as in the laboratory and a skilled observer was designated to follow through each operation and make certain that it complied with the laboratory specifications. Slight variation in "pinch" or annealing temperature caused irregular results in the final oil bath tests. With proper control, the metal came through with final tests which showed variations of less than 10% in number of operations before fracture occurred.

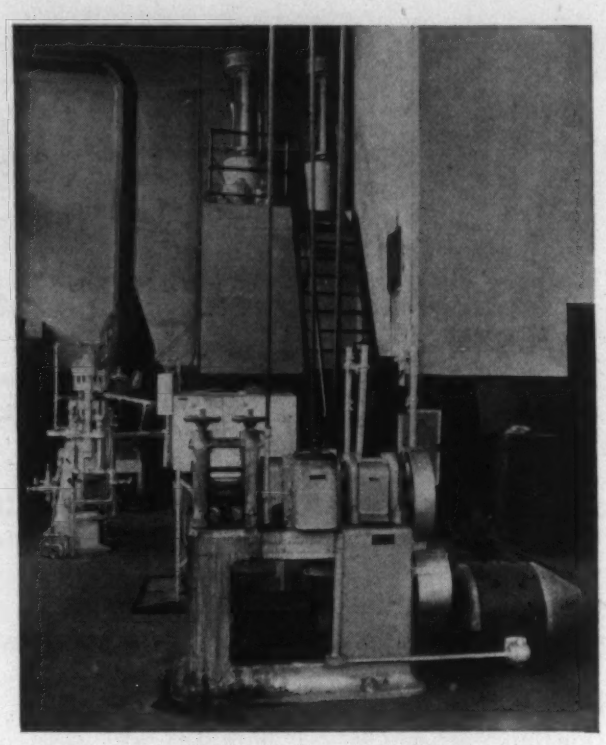
The test results of thermostats made from Adnic indicated uniformity of performance and an exact compliance with the engineer's requirements in that it was necessary to furnish a diaphragm alloy which would not soften, stretch or crack below 5,000,000 operations.

It might be interesting to point out that at the time the engineers developed the longevity oil bath test, the metallurgists criticized it rather forcibly, contending that the test did not approach the action required of the thermostat in actual service where there might be a maximum of 100 complete operations per day, and 2 or 3 times that number of partial operations where the expansion or contraction of the thermostat was only a fraction of the full travel. However, as the metallurgist began to approach the engineer's requirements of the alloy as it developed, he became more enthusiastic over the tests and finally reached the stage where in connection with other work, samples of other alloys were made up into thermostats and tested for comparative

results. The metallurgist now uses the engineer's standard test as a basis for comparing alloys which are called upon to withstand repeated action or flexing, either cold or under high temperatures.

At the time the problem was turned over to the metallurgists by the engineers, the latter admitted their inability to go any farther, for they had practically exhausted all commercial alloys. However, the engineers constructed a foundation for the metallurgists to build on.

With a complete history of the development of both engineers and metallurgists, it is interesting to speculate, or possibly debate whether the problem should have originally been referred to the metallurgist and, if so, would he have been able to develop the alloy without the information submitted by the engineer? Would the metallurgist have been required to go through the same cut and try methods as the engineer and require approximately the same time, or could he pick up the problem and solve it in a simpler fashion and quicker time?



The Experimental Rolling Mill.

I do not believe that the metallurgist would have been able to have solved this problem without the information submitted by the engineer or without the whole hearted coöperation of both engineer and metallurgist. Coöperation is the ability to organize, to get together. This coöperation should be founded on a sane basis and the following story will illustrate this:

A visitor to a State Asylum for the insane was walking over the grounds half a mile from the main building when he came across an attendant in charge of 20 patients. This attendant was a small man, while many of the patients were big men. The comparison arousing the visitor's curiosity, he joined the attendant in a stroll and, among other questions, he asked, "What is to prevent those men getting together and over-powering you; you admit that you are unarmed and there is no help within a mile?" The attendant smiled and replied, "Why, if those men could get together with anybody or anything, they wouldn't be here."

You must get together with the other fellow. In this connection, I am very much indebted to W. K. Simpson, Vice President of the Hoffman Specialty Company, Waterbury, Connecticut, for his presentation of the engineer's viewpoint, his impartial testing of the different alloys and accumulation of engineering information.

While Adnic was essentially developed for a diaphragm metal, it has found a place in many industries where high strength at elevated temperatures and resistance to severe corrosion is desirable. This is especially true in the condenser field where it has given especially long life under severe corrosive conditions in both land and marine installations. It has been on test for over 6 years at the Naval Experiment Engineering Station at Annapolis, Maryland, in an experimental condenser unit along with a dozen other alloys. At the present writing the Adnic tubes are in as good condition as when first installed and show no evidence of corrosion.

The writer believes that he was also the first to publish the fact that certain of the copper-nickel-tin alloys in the Adnic range of composition could be age hardened. In a chill cast alloy consisting of 64.4% copper, 27.6% nickel and 8% tin the Brinell hardness was increased from 114 to 321 after being homogenized for 100 hours at 800°C. and reheated at 500°C.[3] Age hardening of these alloys was also discussed by the writer in connection with the paper "Copper-rich Alloys of the Copper-Nickel-Tin System" by Eash and Upthegrove.[5] At the February meeting of the Institute of Mining & Metallurgical Engineers, E. M. Wise and J. T. Eash presented a paper[6] in which they describe the age hardening characteristics of an alloy of the following composition: Cu 84.5%, Ni 7.5%, Sn 8% which comes within the range of the Copper Nickel Tin alloys covered by my patent. They have the following to say about this alloy:

"The tensile strength of the 7.5% Ni, 8% Sn alloy cold-rolled with 75% reduction was 128,000 lbs./in.^{2} and the proportional limit was 65,500 lbs./in.^{2} coupled with 2.5% elongation. After aging at 600°F. for 5 hours the tensile strength was found to be 170,000 lbs./in.^{2} the proportional limit was 116,000 lbs./in.^{2}, the elongation was 1.5%. The hardness of the unaged 7.5% Ni, 8% Sn alloy cold-rolled with 75% reduction was 260 Brinell, which was raised to 382 by aging at 600°F. for 5 hours."

The same alloy described by the authors, cold rolled with 50% reduction and aged at 600°F. for 5 hours gave a tensile strength of 125,400 lbs./in.^{2}, a proportional limit of 79,800 lbs./in.^{2} with a 11½% elongation in 2", while the Brinell hardness was 292. The alloys were first homogenized at 1400°F. for ½ an hour and then quenched before cold rolling.

There has long been a demand for a white nickel alloy which will resist corrosion, show good strength at elevated temperatures, and not be susceptible to the well known phenomena of season cracking. This alloy fulfills all these requirements and withstands the action of alkalies, hot gases, salt solutions, dilute organic and inorganic acids, and maintains its strength to a remarkable degree at high temperatures.

Many alloys now used for the purposes mentioned above are refractory, and can only be had in the cast form, but Adnic on account of its remarkable ductility, can be drawn, stamped, hot-forged and spun. It can be hot and cold worked, and can be furnished in the form of sheet, wire, rod and tubes.

In conclusion, I wish to especially emphasize the fact that the development of Adnic would never have reached a successful conclusion had it not been for the coöperation and guidance of John H. Goss, vice president and general superintendent of the Scovill Manufacturing Company. His assistance in procuring the necessary apparatus and financial assistance from the board of directors was invaluable and, last, but not least, when the work lagged or seemed to be getting nowhere in particular, the writer was stimulated to carry on by his sympathetic attitude and constructive advice.

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[1]*Proceedings American Society for Testing Materials*, Vol. 24, 1924, Pt. II, Technical Papers, page 424.
[2]William B. Price. U.S. Patent 1,535,542.
[3]Alpha Phase Boundary of the Copper-nickel-tin System, Wm. B. Price, C. G. Grant & A. J. Phillips. Proceedings of the Inst. of Metals Division, 1928, pages 503-514.
[4]Wm. B. Price. Physical Properties of Adnic. *Mining & Metallurgy*, November 1927.
[5]Copper-rich Alloys of the Copper-Nickel-Tin System, Eash and Upthegrove. Trans. A.I.M.M.E. 1933, Inst. of Metals Division, page 249.
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Lowering Welding Costs
by Careful Selection of Steels

by Wilmer E. Stine*

So much attention has been paid recently to the composition and characteristics of electrodes and the characteristics of welding machines that some users are overlooking the important part played by the welding steel itself in the production of better and cheaper welds.

While practically all commercial mild steel can be arc welded, there is most certainly a variation in steels which affects the welding speed, strength of the weld and its cost.

A case recently came to the attention of the writer where a manufacturer of road building machinery suddenly reported numerous difficulties in the welding department. The blame was first laid on the electrodes and then on the welding machines. Other electrodes were tried. The welding machines were carefully inspected and tested. But the trouble was not located until it was noticed that a new shipment of steel was being used and that this steel was of such an analysis as to affect materially its weldability and especially the speed of welding.

It is also true that the quality of the steel to be welded often limits the type of arc weld that can be made. It is very evident that some types of welds can be produced at lower cost and at greater speed than others. The type of weld shown in Fig. 1 can be made in ½-inch plate at a speed of 25 feet per hour (actual welding time). The cost of such a weld will be about one-third to one-half that of the type of weld in ½-inch plate shown in Fig. 2, which will be accomplished at the rate of 9 feet per hour (actual welding time). The more expensive type of weld can be used for welding steels of a very wide range because only a very small percentage of the base metal is mixed with the filler metal. The type of weld shown in Fig. 1 is limited to a narrower range in steel composition if the highest quality weld is to be obtained because a much higher percentage of base metal enters into the composition of the weld metal.

If high strength and ductility are required for a given weld, the chemical composition of such weld metal will have to be kept within narrower limits than is necessary for rolled or cast steel because of the more rapid cooling from high temperature.

It will generally be found that for good ductility, the carbon content of weld metal will have to be kept below .12%.

The chemical analysis of the steel used in a modern shielded arc electrode for metallic arc welding will be about as follows:

Carbon	Manganese	Phosphorus	Sulphur	Silicon
.13	.45	.015	.03	.008

This steel will invariably be of the open or rimmed type.

To bring the composition of this material within the range for ductile weld metal it will only be necessary to oxidize out a small amount of the carbon. This is readily brought about by the high temperature in arc welding which facilitates the oxidation of carbon in preference to the manganese or iron. Because of the close control maintained over composition of the electrode it is possible to make ductile welds of the type shown in Fig. 2 in a wide variety of steels where the base metal forms only a small percentage of the weld metal. Thus we can make a ductile weld of this type in such a steel as silicon structural steel which may have a composition of .30% carbon and .30% silicon. If the weld metal is made up of 10% base metal and 90% electrode and we could mix them without any chemical change, the resultant mixture would be .147% carbon and .037% silicon. We would thus be within easy striking distance of ductile weld metal.

If the base metal and filler metal were both .30% carbon and .30% silicon, the silicon would interfere sufficiently with oxidation of the carbon to prevent the carbon from dropping to the range necessary for high ductility and the high silicon content would introduce other complications. We would therefore probably not secure

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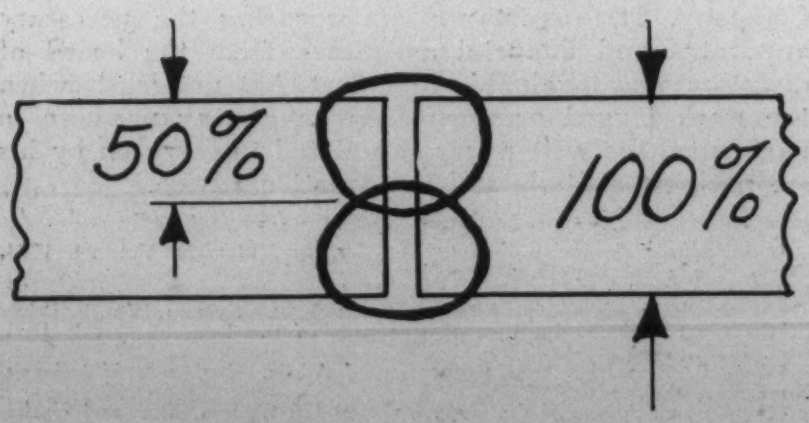

Fig. 1. Plain butt weld, welded from both sides.

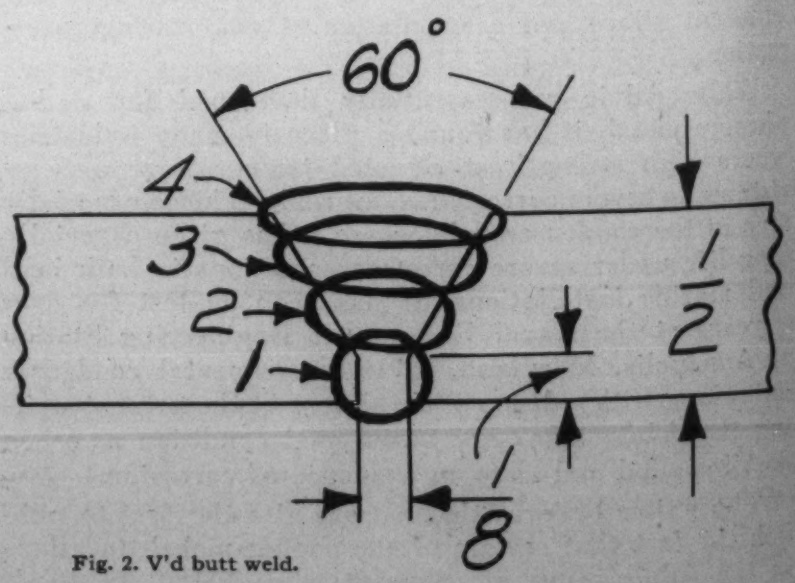

Fig. 2. V'd butt weld.

a very ductile weld in silicon structural steel of the type shown in Fig. 1.

Because of the higher cost of the steel in metallic electrodes, the most economical type of weld will generally be that type in which the minimum amount of electrode or filler metal is used (See Fig. 2). In Fig. 1 for example, a square butt joint uses much less filler metal than a vee'd joint, and the smaller the vee, the less filler metal is used. *Then it follows that the composition of the base metal is of major importance, where the most economical type of weld is desired* and the discussion which follows is based on this premise, i.e., the economical type of weld, Fig. 1.

Therefore, a study of the most economical form of welding will include composition or weldability of the base metal. Ductility, however, is not the only essential of weld metal. In many cases the welds must be of good appearance and free from porosity. From the foregoing it will be seen that the most economical steel to weld is that which when raised to a high temperature in the arc welding process, flows smoothly and cools without the evolution of gases during solidification and retains desirable physical properties. It will therefore be seen that there are many factors which will affect the welding speed, strength and cost of welds.

Any one of the following factors may affect the welding characteristics of steel:

1. Oxidation
2. Non-metallic inclusions
3. Change of structure
4. Solvent power of the metal for gas
5. Hot shortness or low strength of metal at high temperature
6. Cold shortness or low strength of metal at low temperatures

Oxidation may produce a gaseous oxide causing gas holes. It may produce solid oxides resulting in slag inclusions or solid soluble oxides which render the metal brittle or of low strength.

Some metals may contain finely divided non-metallic inclusions having a melting point higher than that of the steel, which melt under the high temperature of the arc, coalesce and form visible slag inclusions or slag holes.

Change of structure of the base metal during welding may take place, causing a change in physical property. This is generally true of the higher carbon steels and some of the alloy steels.

Oxidation by removal of some of the elements may change the capacity of the steel to hold certain gases at solidifying temperature, causing them to be evolved, resulting in porosity in the weld metal.

One of the common causes of hot shortness is a high sulphur content. Non-metallic inclusions high in SiO_2 may also cause hot shortness. One of the common causes of cold shortness is high phosphorus content. These factors determine the extent to which some steels weld better than others.

Research has revealed that many additions, impurities and alloying elements used in steel affect the arc welding characteristics of the steel. Some of these elements are not limited by the usual steel specifications. Thus two lots of steel purchased under the same commercial specifications may have different welding characteristics. Some of the elements found in steel which may affect its gas solvent power and arc welding characteristics are aluminum, silicon, carbon, manganese, titanium, nickel, vanadium, chromium and molybdenum.

For example, steel having a carbon content below .15% has a higher gas absorption power. Thus when such steel is welded considerable quantities of gas in the ambient atmosphere are absorbed by the molten metal. It is therefore essential that the arc welds in such steel be completely shielded during welding. Research further reveals that steel having a silicon content of about .1% greater may make welding unsatisfactory unless other alloying or deoxidizing elements are present. Also a content of more than .01% of aluminum may cause a poor weld unless the steel also contains a certain proportion of other deoxidizing elements.

If the steel contains slag inclusions which have a melting temperature between 1600° and 2500° C., they may melt, coalesce before freezing and form slag pits in the weld. Alumina, Al_2O_3, is a typical example of such slag material and may result from deoxidizing steel with aluminum, or it may come from the furnace or ladle lining.

In tests made in the Lincoln laboratories it has been found that steel which formed slag holes in the weld, as shown in Fig. 3 invariably had been aluminum killed and contained an appreciable amount of Al_2O_3. This characteristic was checked by covering a piece of good welding steel with a thin layer of Al_2O_3 before welding it. The result was very similar to that shown in Fig. 3.

Fig. 3. Left. Weld in steel showing slag holes due to high aluminum oxide content. .03% aluminum oxide present.

Fig. 4. Right. Weld in steel showing poor welding quality due to high aluminum content.

Fig. 5. Below. High silicon content in the steel is responsible for the poor weld on this specimen.

It has been fairly well established that the capacity of steel for holding gases in solution (the cause of gas holes) varies with temperature and the content of aluminum, silicon, manganese and carbon content.

Fig. 4 shows a porous weld caused by an excess of aluminum. Fig. 5 illustrates a porous weld caused by the presence of too much silicon.

The effect of manganese is not so pronounced as that of silicon and aluminum. However, a steel containing 1.5% manganese will generally show porosity unless it contains some vanadium. For some unexplained reason there is a manganese range around .25% which produces steel of poor welding quality probably because of relatively high solubility for nitrogen. It has been shown by laboratory tests that steel of .25% manganese melted in an air atmosphere will absorb 10 times as much gas as a steel of the same carbon content containing .44% manganese and 5 times as much as a steel containing .10% manganese.

It has been shown that a small addition of aluminum counteracts some of the bad effects of silicon in producing porosity and also in lowering the melting temperature of the products of de-oxidation.

It is also known that vanadium is effective in reducing porosity in high manganese steels and steels which have been killed with silicon.

From the above discussion of the difficulties encountered in welding steel of various analyses, it may appear that where sound, tough welds are desired, only certain grades of steel can be used. This, however, is not entirely conclusive, as it has been found that with proper welding procedure with a completely shielded arc and in some cases with the addition of a corrective flux applied to the material to be welded, or by addition of filler metal of correct composition, welds of good physical characteristics can be produced in practically all grades of steel, that would give unsatisfactory results without these corrective measures.

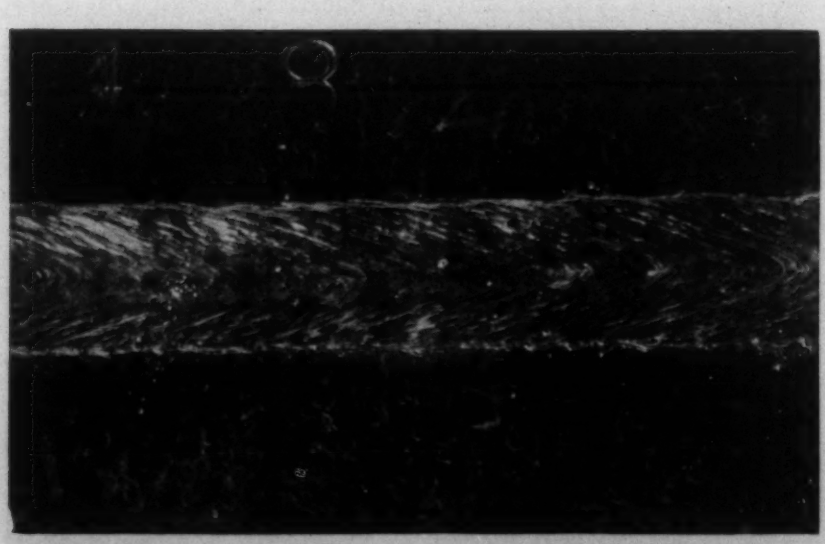

Fig. 6. An excellent weld. This specimen was made in steel of good welding quality at maximum speed.

Steels conforming with the following specifications will be of good welding quality. It should be noted in the following specifications for steels that if aluminum is added along with silicon the specified limits for silicon and aluminum do not apply provided the ratio of silicon to aluminum used in ladle or molds is not less than 5 to 1 or greater than 15 to 1. The general purpose steel, the analysis of which immediately follows, is the best for arc welding at high speeds and should be used in all cases where physical requirements permit.

Analysis of General Purpose Steel

	% Recommended	% Limits
Carbon	.20	.15 to .25
Manganese	.45	*.35 to .60
Silicon	.04	.07 max.
Sulphur	.....	.05 max.
Phosphorus	.....	.045 max.
Aluminum	none added	not over 2 oz. per ton added to steel.

The maximum welding speed for soft steel, which permits considerable cold forming, will generally be less than that for the higher carbon general purpose steel.

Analysis of Steel for Considerable Cold Forming

	% Recommended	% Limits
Carbon	(As high as practical)	.07 to .15
Manganese	.40	*.35 to .55
Silicon	.....	.05 max.
Sulphur	.....	.05 max.
Phosphorus	.....	.045 max.
Aluminum	none added	not over 2 oz. per ton added to steel

It should be clearly understood that all commercial grades of steel are weldable but if steel conforming to the above specifications is used, the best results in strength, welding speed and economy will be obtained.

Suppose we have a steel which does not meet the specifications given above for good weldability. Tests run on welding speed will show a marked difference in the welding time for a given operation. The speed may be decreased 25% or even more in order to get a sound weld. Let us assume that it is only 20%. That means that you are increasing your labor cost, the principal item in most welding, 20% and you are increasing the current cost. In fact the total cost of your welding would be increased more than 15%. In addition, the capacity of the shop would be cut considerably, placing a higher overhead cost on the welding department. In some cases it may be necessary to use the more expensive type of weld shown in Fig. 2 in order to get satisfactory quality of weld metal.

To avoid such a condition it is not necessary to pay more for steel. There is no difference in the price of steel having good welding characteristics. It is merely a question of using greater care in the purchasing of steel in order to make sure that metal of the proper analysis is secured. Then welds will be sound, speed will be at the maximum and costs will be at the lowest.

*Higher low limit because of the poor characteristics of .25% manganese range as described above.

Ralph G. Caulley has joined the Detroit District Sales office of Republic Steel Corporation, according to announcement made by N. J. Clarke, Vice-President in charge of sales. Mr. Caulley had been connected with Wheeling Steel Corporation for 14 years, the last seven of which were spent in the Detroit district.

A. E. Baldwin, President, and **L. K. Lindahl**, General Manager of the Udylite Process Company, Detroit, Mich., recently departed on an inspection trip, during which they will visit prominent Udylite installations in the West Coast and make a survey of business conditions in the western portion of the country.

ADNIC

A White Metal Alloy for Corrosion-resistance and for Moderate Temperature Heat-resistance

by William B. Price*

THE FOLLOWING article describes the physical properties of "Adnic," an alloy consisting of 70% copper, 29% nickel and 1% tin, at ordinary and elevated temperatures, its corrosion resistance properties and its creep characteristics at elevated temperatures.

The name Adnic is an abbreviation from Admiralty Nickel, the proportion of copper and tin being the same as in regular Admiralty condenser metal, with 29% nickel replacing the same percentage of zinc.

In the November 1927 issue of *Mining & Metallurgy* some of the physical properties of this alloy at ordinary and elevated temperatures were published by the writer. Certain of these are reproduced below.

The physical properties and physical constants of this and of other well-known alloys, are summarized in the table below.

Physical Properties of	½" Hard Rod of Al-Bronze 5% Al	½" Hard Rod of Al-Bronze 8% Al	½" Hard Rod of Al-Bronze 10% Al	½" Hard Rod of 75% Cu 20% Ni 5% Zn	½" Hard Rod of 70% Cu 29% Ni 1% Sn	1" Hot Rolled Hexagon Rod of Adnic
Modulus of elasticity, lbs./in.²				19,000,000	21,300,000	
Elastic limit, lbs./in.²				75,000	85,000	30,500
Yield point, lbs./in.²					107,000	35,600
Tensile strength, lbs./in.²	69,000	83,000	96,000	80,000	113,200	64,500
Elongation, in 2", %	12 (in 10")	20 (in 10")	5 (in 10")	12	10	46
Reduction in area, %					56½	72.2
Scleroscopic hardness (U. hammer)					31	
Coefficient of thermal expansion, /°C.				0.0000164	0.0000163	
Electrical resistivity at 20°C., ohms/arc. mil-foot				172	256	
Melting point, °C.				1,150	1,205	
Density at 20°C. (68°F.) lbs./in.³				0.319	0.321	

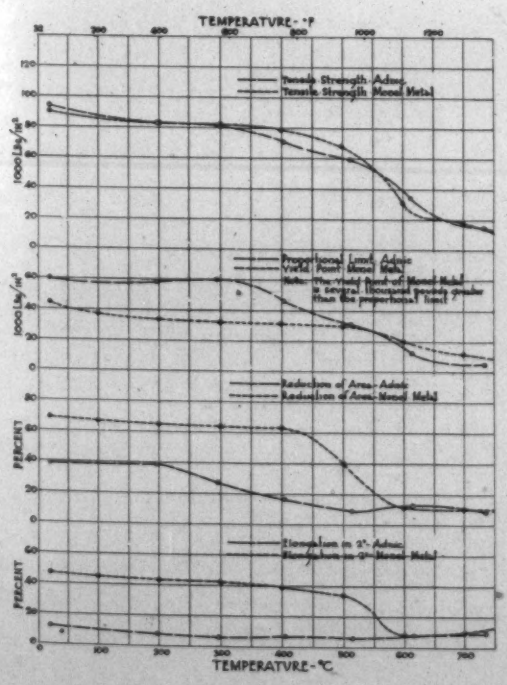

Fig. 1 shows comparative data for Adnic and Monel metal, compiled from tests made by the U. S. Bureau of Standards. The Adnic was flat metal, rolled 4 numbers hard, having a tensile strength of 94,000 lbs./in.²

In Fig. 2, physical properties as determined in the laboratory of the Scovill Manufacturing Company at elevated temperatures are given. The Adnic used in these tests was annealed 1" rod, having a tensile strength of 64,000 lbs./in.² The yield point and elastic limit values are abnormally high for an annealed non-ferrous alloy, which is doubtless due to a carbon content of 0.11%, approximately twice the normal. The sample also carried 0.7% impurities such as Fe, Si and Zn. The differences in the temperatures at which the reduction of area begins to fall off on Figs. 1 and 2 are characteristic of the behavior of hard rolled and annealed material at elevated temperatures.

The data derived from such charts are helpful in determining the hot-working range. The best hot-working range for this alloy lies between 850° and 1100°C. It also illustrates the freedom of the alloy from any decided "hot shortness." The fact that the elastic limit at 500°C. is nearly 30,000 lbs./in.² is of great importance when Adnic is used for service at elevated temperatures.

A typical analysis which was successfully hot rolled into sheet and rod form is as follows: Cu 69.12%; Fe 0.18%; Sn 1.03%; Ni 28.23%; Mn 0.94%; S 0.01%; C 0.06%; Zn (diff.) 0.43%.

Fig. 1. (left) Physical Properties of Monel Metal and Adnic at Elevated Temperatures.

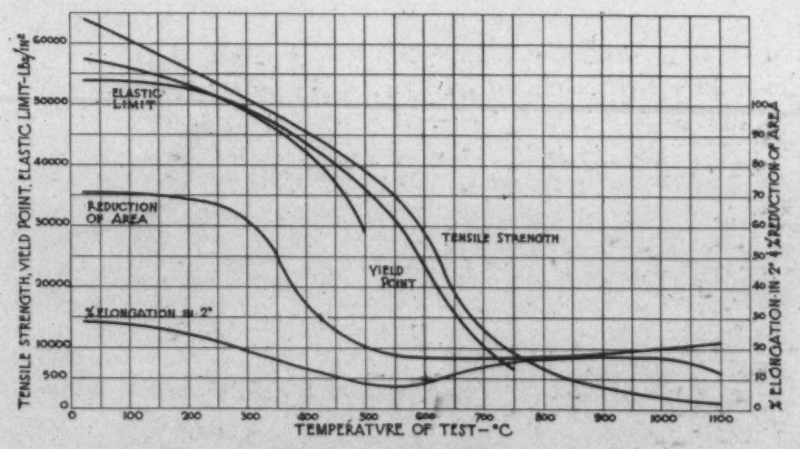

Fig. 2. Tensile Properties of Adnic Rod at Elevated Temperatures.

When cold-drawn in wire form to 0.006" diameter with 99.6% final reduction, the alloy has a tensile strength of approximately 131,000 lbs./in.², and an elongation of 2% in 2 inches. In the annealed state it has a tensile strength of approximately 77,000 lbs./in.², and an elongation of about 35% in 2 inches.

For comparative purposes the tensile strength of ⅜ in. hot-rolled rod of 96% Cu, 3% Si, 1% Mn at elevated temperatures, determined by U. S. Bureau of Standards, is given below:

Temp. °F.	Ultimate Strength lbs./in.²	Elongation in 2" %	Reduction of Area %
80	72,650	43.5	51.0
500	60,200	33.0	67.4
750	35,930	25.5	69.4
1,000	14,480	18.0	71.4
Thermal conductivity, B.t.u./ft.²/hr., 1 in. thickness			72.6
Electrical resistivity, ohms/cir. mil-foot			186
Coefficient of linear expansion, /°C.			0.0000170

*Chief Chemist and Metallurgist, Scovill Mfg. Co.

The wire and strip for the present tests came from 3 sources: wire from the International Nickel Co., wire and flat metal from the Ludlum Steel Co., and flat metal from the Scovill Mfg. Co.

The International Nickel Co. cast and hot worked the material for wire to 3/8" round, from which point it was cold drawn to .257" and annealed by the Scovill Mfg. Co. The Ludlum Steel Co. cast and hot worked material for wire to 1/2" round and that for flat metal to 0.599" from which points it was cold processed by the Scovill Mfg. Co. The Scovill Mfg. Co. cast 2 1/2" bars and cold processed them to .102".

Material for the wire drawing series was started soft on .257" and drawn in stages to 10# hard on production wire drawing equipment.

All material for flat metal tests was received from the mills in a hard worked condition on .102" and was then annealed and rolled using laboratory equipment.

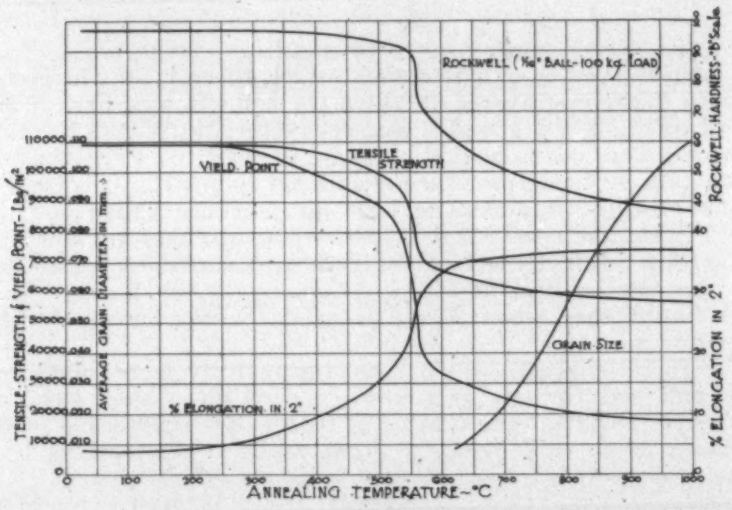

Fig. 3. Annealing Series Test on Hot Worked 0.102 inch Adnic Strip. Analysis: Cu—71.21 %, Fe—0.35 %, Sn—1.07 %, Ni—26.42 %, C—0.04 %, Mn—0.56 %, Si—0.12 %, Zn (diff.)—0.23 %. Material cast and hot worked to 0.599 inch by Ludlum Steel Co., then cold rolled to 0.102 inch by Scovill Mfg. Co., 15 # hard (Reduced 83 %) before annealing.

The tensile test specimens for flat metal were machined according to A.S.T.M. specifications.

Wire test specimens were straightened and tested without machining. The test on any sample which broke outside the gage length was repeated until the sample broke within the gage marks.

Tensile tests were made on a 50,000 lb. "lever type" testing machine using a 5000 lb. capacity poise. Templin grips were used. Yield points were measured with a Berry strain gage reading to .0002" and represent those stresses at which the permanent set is .01" in 2" or 1/2%. The speed of tensile test in no case exceeded 1"/minute.

The Rockwell and Scleroscope hardness tests were made with penetrators and loads as indicated on the graphs. The Vickers diamond pyramid hardness values are presented as relative numbers but are closely related to Brinell hardness and may be read as kg./mm.^{2} Hardness measurements were taken on carefully cleaned surfaces.

The annealing series of Fig. 3 shows the recrystallization temperature of Adnic when very hard worked (cold rolled 83%) to be about 560°C.

Micrographs in Fig. 4 illustrate the grain growth curve shown on Fig. 3. Grain growth after recrystallization is nearly in direct proportion to the annealing temperature.

Annealing series of Fig. 5 was made to check the series on metal processed by the Ludlum Steel Co. (Fig. 3). The Ludlum metal was originally hot-worked, then cold rolled 15# hard before annealing in an open muffle. The Scovill metal (Fig. 5) was cold rolled 6# hard before annealing in a container with charcoal. A comparison of the 2 series shows no important difference. As would be expected, the recrystallization temperature of the more lightly worked material is slightly higher (about 565°C.).

Figs. 6, 7 and 8 show the effect of cold rolling on the physical properties of strip. All material for these tests was from the same bar used on tests for Fig. 3.

Figs. 9 and 10 show the effect of variation in composition on the physical properties of cold drawn Adnic wire. The wire from the International Nickel Co. has about 3% less Cu, 3% more Ni and 1/2% more Zn than that from the Ludlum Steel

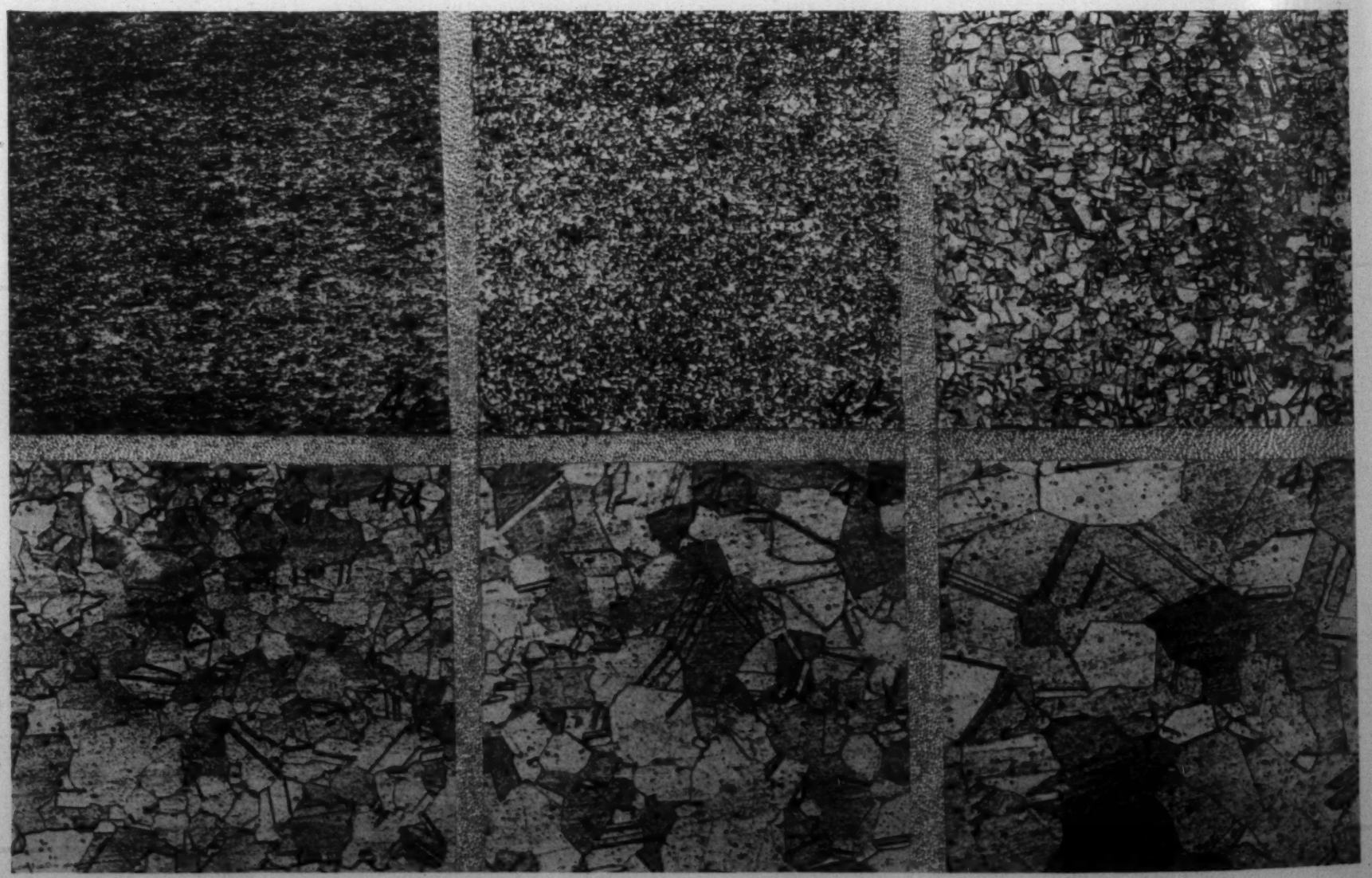

Fig. 4. Magnifications 75X, Etchant Nitric and Acetic Acids.
(a) 15 # Hard—Reduced 83 %. **(b) Annealed 620°C.—Grain Size 0.009 mm.** **(c) Annealed 710°C.—Grain Size 0.025 mm.**
(d) Annealed 810°C.—Grain Size 0.065 mm. **(e) Annealed 930°C.—Grain Size 0.090 mm.** **(f) Annealed 1000°C.—Grain Size 0.110 mm.**

Co. The lower Cu, higher Ni material was originally softer, hardens faster and reaches a greater final strength. Therefore, in order to obtain the best all around combination of physical properties for both hot and cold working, it is desirable to keep the Ni as close to 29% as possible, Cu between 69 and 70%, Sn 1%, Mn between 0.10 to 0.25%, Fe 0.25% max., Si 0.05% max., and C 0.04% max.

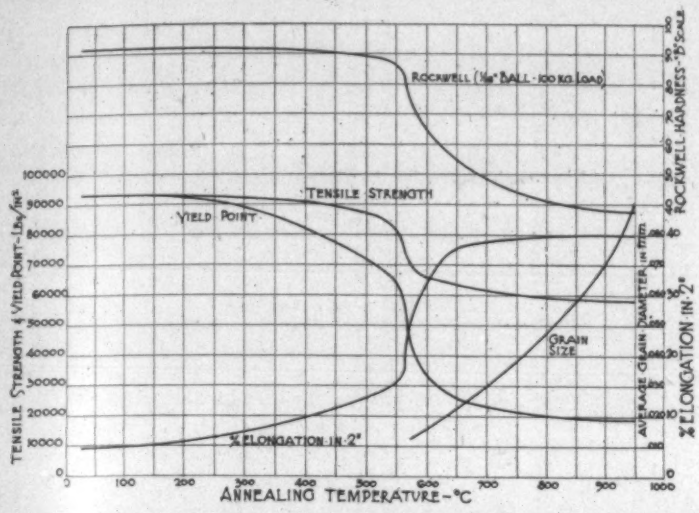
ROCKWELL ("16" BALL - 100 KG LOAD)
ROCKWELL HARDNESS - "B" SCALE
TENSILE STRENGTH
YIELD POINT
GRAIN SIZE
AVERAGE GRAIN DIAMETER IN MM.
% ELONGATION IN 2"
TENSILE STRENGTH & YIELD POINT - Lbs/in²
ANNEALING TEMPERATURE - °C

Fig. 5. Annealing Series Test on Cold Rolled 0.100 inch Adnic Strip. Analysis: Cu—71.29 %, Fe—0.42 %, Sn—1.12 %, Ni—26.38 %, C—0.04 %, Mn—0.57 %, Si—0.14 %, Zn (diff.)—0.04 %.
Material cast and cold rolled by Scovill Mfg. Co., 6 # hard (Reduced 50 %) before annealing.

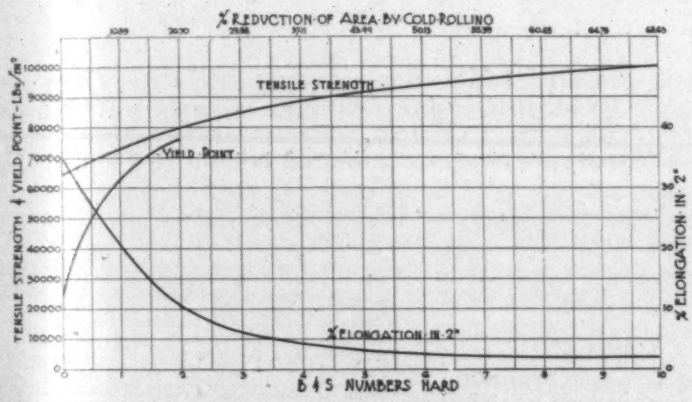
% REDUCTION OF AREA BY COLD ROLLING
TENSILE STRENGTH
YIELD POINT
% ELONGATION IN 2"
TENSILE STRENGTH & YIELD POINT - Lbs/in²
% ELONGATION IN 2"
B & S NUMBERS HARD

Fig. 6. Effect of Cold Rolling on Tensile Properties of Adnic Strip, 780°C. Anneal before Rolling. Gage: Soft—0.102 inch; 10 # hard—0.032 inch.

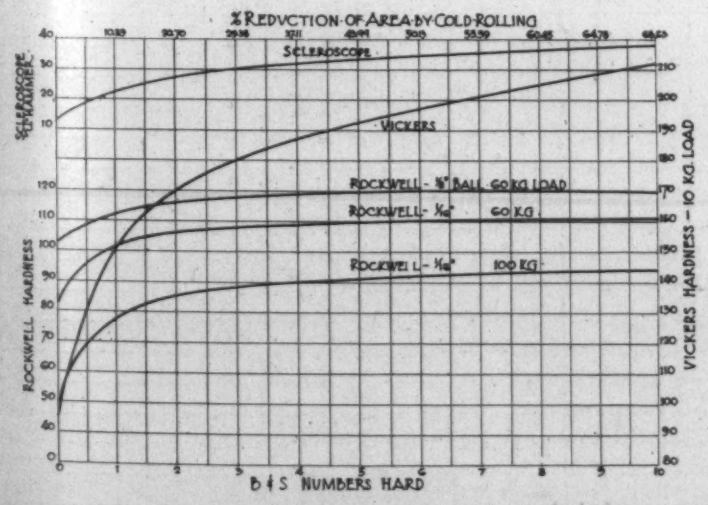
% REDUCTION OF AREA BY COLD ROLLING
SCLEROSCOPE
VICKERS
ROCKWELL - ⅛" BALL 60 KG LOAD
ROCKWELL - 1/16" 60 KG
ROCKWELL - 1/16" 100 KG
ROCKWELL HARDNESS
VICKERS HARDNESS - 10 KG LOAD
B & S NUMBERS HARD

Fig. 7. Effect of Cold Rolling on Hardness of Adnic Strip, 780°C. Anneal before Rolling. Gage: Soft—0.102 inch; 10 # hard—0.032 inch.

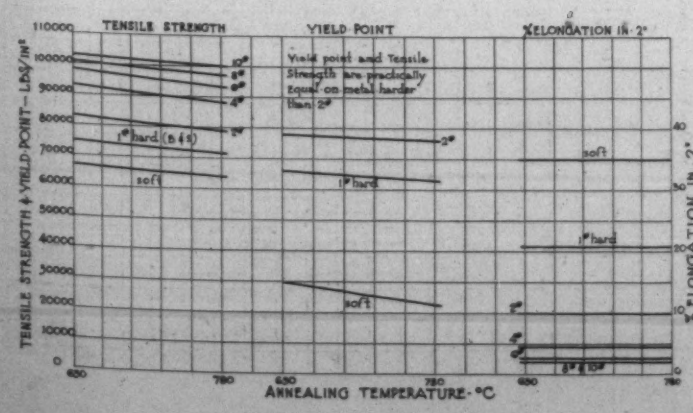
TENSILE STRENGTH
YIELD POINT
% ELONGATION IN 2"
Yield point and Tensile Strength are practically equal on metal harder than 2#
TENSILE STRENGTH & YIELD POINT - LBS/in²
% ELONGATION IN 2"
ANNEALING TEMPERATURE - °C

Fig. 8. Effect of Annealing Temperature on Tensile Properties of Adnic Strip. Gage: Soft—0.102 inch; 10 # hard—0.032 inch.

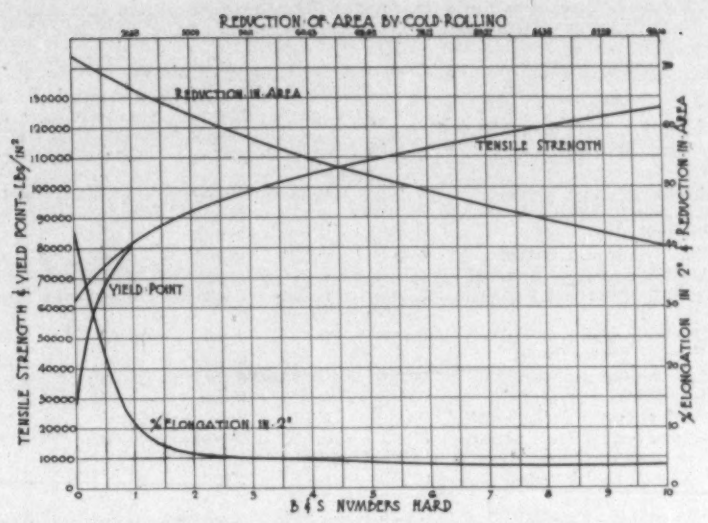
REDUCTION OF AREA BY COLD ROLLING
REDUCTION IN AREA
TENSILE STRENGTH
YIELD POINT
% ELONGATION IN 2"
TENSILE STRENGTH & YIELD POINT - Lbs/in²
% ELONGATION IN 2" & REDUCTION IN AREA
B & S NUMBERS HARD

Fig. 9. Effect of Cold Drawing on Tensile Properties of Adnic Wire. Analysis: Cu—68.15 %, Fe—0.60 %, Sn—1.11 %, Ni—28.37 %, C—0.04 %, Mn—0.51 %, Si—0.05 %, Zn (diff.)—1.17 %.
Material cast and hot worked to ⅜ inch wire by International Nickel Company, then cold drawn by Scovill Mfg. Co. Gage: Soft—0.257 inch (Grain Size 0.045 mm.); 10 # Hard—0.081 inch.

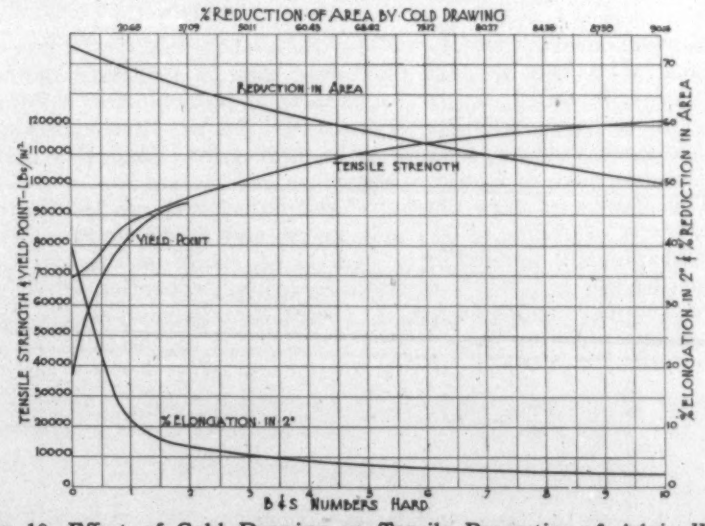
% REDUCTION OF AREA BY COLD DRAWING
REDUCTION IN AREA
TENSILE STRENGTH
YIELD POINT
% ELONGATION IN 2"
TENSILE STRENGTH & YIELD POINT - Lbs/in²
% ELONGATION IN 2" & REDUCTION IN AREA
B & S NUMBERS HARD

Fig. 10. Effect of Cold Drawing on Tensile Properties of Adnic Wire. Analysis: Cu—71.34 %, Fe—0.41 %, Sn—1.14 %, Ni—25.88 %, C—0.04 %, Mn—0.55 %, Si—0.14 %, Zn (diff.)—0.50 %.
Material cast and hot worked to ½ inch wire by Ludlum Steel Company, then cold drawn by Scovill Mfg. Co. Gage: Soft—0.257 inch (Grain Size —0.037 mm.); 10 # Hard—0.081 inch.

Corrosion Resistance of Adnic

The corrosion resistance of Adnic is an important factor in many of its commercial applications. In addition to its favorable mechanical properties and workability, this alloy can be used to advantage under varied service conditions. It is basically a copper-nickel alloy of the type which has been used extensively for corrosion resistant properties for many years. It has the typical corrosion resistance of these alloys enhanced by the added tin content.

Corrosion tests in various media under a wide number of testing conditions indicate in some measure its resistance to attack by acids, alkalies and neutral salt solutions. In Table 1, are given the results of tests on various metals and alloys immersed in 4% sodium hydroxide solution. These results, as well as those of the tests given in Table 2, show that Adnic is only very slightly attacked by moderate concentrations of cold sodium hydroxide and rates very favorably in this respect with pure nickel and the higher nickel alloys and is distinctly superior to Admiralty metal and copper in its resistance to attack by sodium hydroxide solutions.

The aerated and non-aerated total immersion tests and the interrupted and continuous alternate immersion tests and the salt spray test in various corroding media listed in Table 2 give a measure of comparison of the corrosion resistance of pure nickel, Adnic and Admiralty metal under the particular

Table 1. Corrosion Tests on Various Metals in 4% Sodium Hydroxide*

	Corrosion Rate—Milligrams per sq. decimeter per day				
	Quiet immersion	Air-agitated solution	Continuous alternate immersion	Intermittent alternate immersion	Spray test
Nickel	.3	.3	3.1	3.7	.3
Monel metal	1.0	1.3	.4	.9	<.1
Copper-nickel (54-45)	.5	.6	.4	.4	<.1
Adnic (70-29, 1% tin)	.2	.3	.9	.5	<.1
Copper	13.6	20.5	29.2	14.3	2.0
Admiralty brass	12.0	33.5	54	24	1.2
Zinc	90	175	1850	450	2.8
Lead	75	370	5500	2200	9.5
Aluminum	26000	26000	7900	1300	13.0

*Abstracted from a report by H. E. Searle and R. Worthington, Development and Research Dept., International Nickel Co.

Table 2. Corrosion Tests, Bureau of Standards Results of Adnic and A.S.T.M Results on Admiralty Metal and Pure Nickel.

Medium	Loss in Weight Milligrams per sq. centimeter per day* Total immersion Non-aerated	Total immersion Aerated	Alternate immersion Intermittent	Alternate immersion Continuous	Spray
		Adnic			
Hydrochloric acid 1 normal	0.495	28.64	0.509	4.71	0.434
Acetic acid 1 normal	0.179	0.728	0.014	0.227	1.036
Sodium chloride 1 normal	0.021	0.038	0.022	0.036	0.003
Sodium hydroxide 1 normal	0.002	0.003	0.004	0.008	+0.0005
Ammonium hydroxide 1 normal	0.013	0.016	0.023	0.088	0.0047
Potassium bichromate 1 normal	0.005	0.002	0.001	0.001	0.0002
		Admiralty Metal			
Hydrochloric acid 1 normal	0.950	35	3.25	19.0	2.50
Acetic acid 1 normal	0.200	0.700	0.425	0.550	1.25
Sodium chloride 1 normal	0.125	0.125	0.035	0.080	0.045
Sodium hydroxide 1 normal	0.175	0.325	0.225	0.500	0.0125
Ammonium hydroxide 1 normal	0.950	5.75	2.0	15.0	0.220
Potassium bichromate 1 normal	0.013	0.010	0.0085	0.005	<0.001
		Pure Nickel			
Hydrochloric acid 1 normal	0.550	1.75	4.00	10.0	0.800
Acetic acid 1 normal	0.225	1.40	0.700	1.60	0.300
Sodium chloride 1 normal	0.019	0.017	0.042	0.025	0.0025
Sodium hydroxide 1 normal	0.004	<0.001	0.038	0.035	0.0035
Ammonium hydroxide 1 normal	0.043	0.006	0.025	0.150	<0.001
Potassium bichromate 1 normal	0.010	0.007	0.010	0.017	<0.001

*In comparing these data with those of the preceding table it should be noted that the preceding table is based on the square decimeter as the unit of area. This table on the square centimeter.

conditions of testing. It will be noted that the resistance to attack of Adnic by such corroding agents as dilute mineral and organic acids, caustic soda and sodium chloride solutions is in most cases equal or superior to that of pure nickel and in all cases shows a definite advantage over Admiralty metal in its corrosion resistance.

The results of some long time salt spray tests on tensile test specimens of Adnic, Admiralty metal and 80-20 copper nickel are graphically presented in Fig. 11. A study of these results indicates the superior corrosion resisting properties of Adnic to salt spray atmospheres. A visual examination of the test specimens gives an even better comparison of the behavior of these alloys under corrosive atmospheres. After 5 years testing

Table 3. Salt Spray Test of Adnic, Admiralty Metal and 80-20 Cupro-Nickel

Sample No.	Salt Spray (Weeks)	% Weight Loss	T.S. lbs./in.^{2}	% Elong. 2"
	Adnic—70 Cu 29 Ni 1 Sn—Cold Worked			
1	0	0.00	108000	3.7
2	27	0.97	104400	3.0
3	54	1.47	104300	3.0
4	126	4.07		
5	252	9.68	92100	2.0
	Adnic—Annealed			
1	0	0.00	61000	38.0
2	27	0.95	60300	35.0
3	54	1.33	60200	38.0
4	126	3.21		
5	252	7.56	54000	27.0
	Admiralty Metal—70 Cu 29 Zn 1 Sn—Cold Worked			
1	0	0.00	96700	3.0
2	27	1.16	87200	3.0
3	54	4.57	87400	2.0
4	126	11.63		
5	252	15.24	71500	2.0
	Admiralty Metal—Annealed			
1	0	0.00	47000	73.0
2	27	1.69	44000	54.0
3	54	3.53	42400	49.0
4	126	8.30		
5	252	12.52	32500	36.0
	80 Cu 20 Ni—Cold Worked			
1	0	0.00	90500	3.5
2	27	1.42	82000	2.5
3	54	2.15	81600	2.5
4	126	6.37		
5	252	11.39	73900	2.0
	80 Cu 20 Ni—Annealed			
1	0	0.00	49300	42.0
2	27	1.47	47700	31.0
3	54	1.96	47800	32.0
4	126	4.71		
5	252	8.19	38000	17.0

in salt spray, the Adnic samples were entirely free from pitting whereas the copper nickel was very severely pitted over its surface. Adnic was free from evidences of dezincification, while the Admiralty metal samples showed both pitting and dezincification.

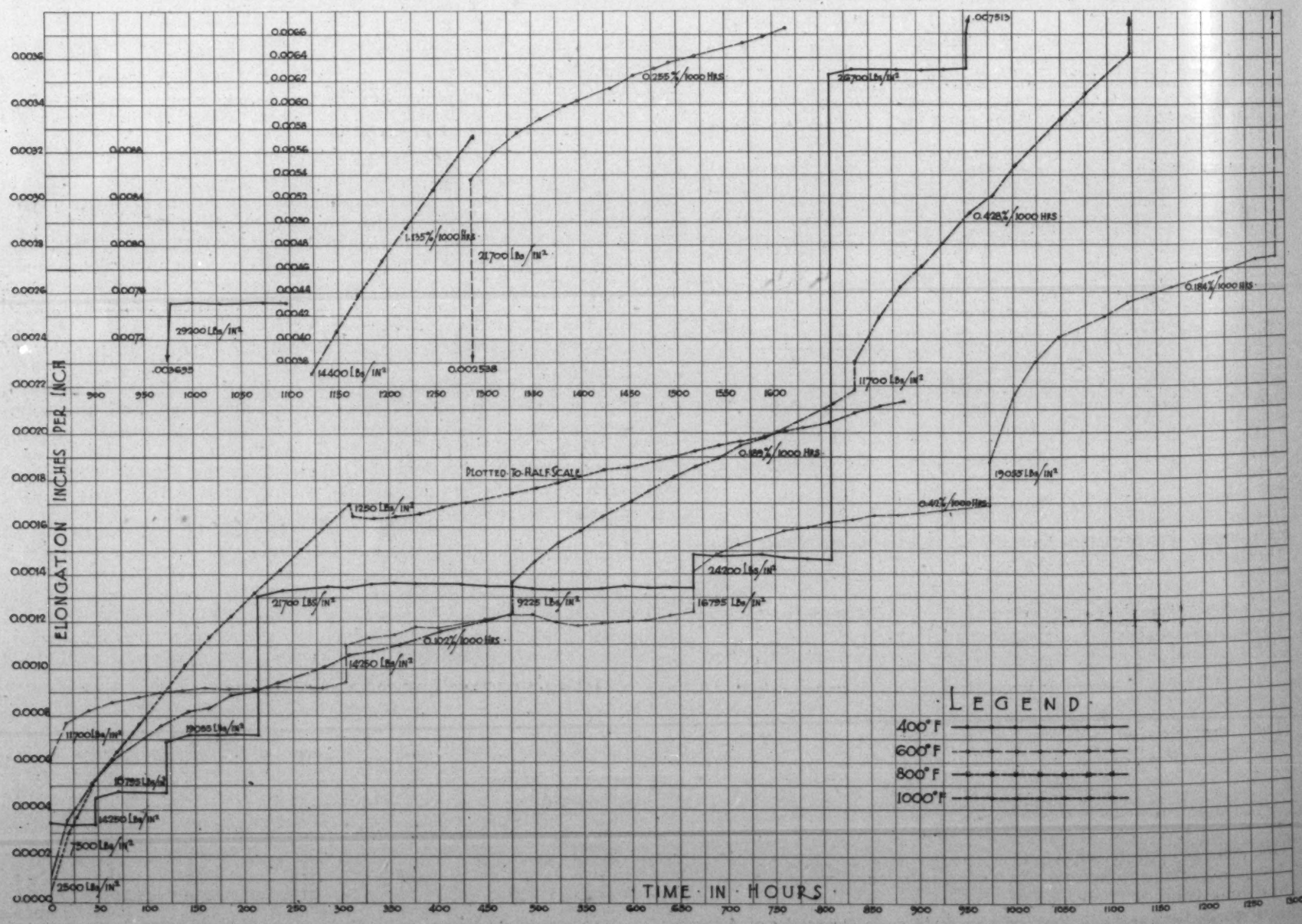

Fig. 12. Time—Elongation Curves of Adnic Metal at 400°, 600°, 800° and 1000° F.

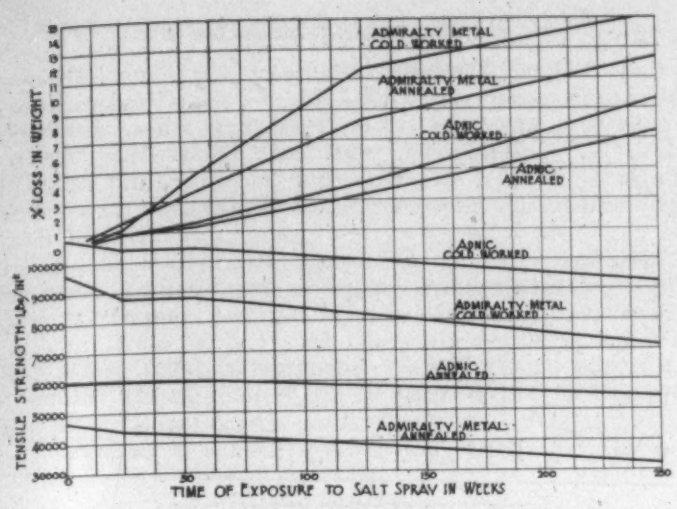

Fig. 11. Time of Exposure to Salt Spray in Weeks.

The results of these laboratory corrosion tests are a convincing proof of the corrosion-resistant properties of Adnic. Service tests of the alloy in corrosive atmospheres or in contact with corrosive solutions fully substantiate the laboratory results. As an example of one application where Adnic has proven its ability to resist corrosion, its use for condenser tubes may be mentioned. Under very severe conditions of service, Adnic condenser tubes have shown a service life many times that of Admiralty metal and other corrosion resistant alloys.

Creep Characteristics of Adnic Metal at Elevated Temperatures

This investigation was carried out by C. L. Clark at the University of Michigan for the Scovill Mfg. Co. The temperatures selected for this work were 400°, 600°, 800° and 1000°F. The material for this study was supplied by the International Nickel Company in ¾ inch diameter hot rolled bars. Its physical properties were approximately as follows:

Elastic Limit	Yield Point	Tensile Strength	Reduction of Area	Elongation in 2″
30,500 lbs./in.²	35,600 lbs./in.²	64,500 lbs./in.²	72.2%	46%

The procedure used in these tests has been fully described in the literature.[1]

The apparatus is of the single lever type with a lever ratio of 24 to 1. A standard 0.505″ diameter test specimen with a 2″ gage length is employed and the specimen is heated by a calibrated electric resistance furnace. The temperature variations over the test piece are not greater than 10°F. The temperature of each furnace is controlled by an individual Wilson-Maeulen temperature controller and the control thermocouple is placed in direct contact with the winding of the furnace. The temperature is controlled by this method to within ±2°F.

The elongation of the specimen is measured by an optical system which is attached directly to the gage section of the test piece. The sensitivity of measurement is 0.0000028″.

The "up-step" method of loading was employed in these tests. That is, a given fixed load was applied and held constant until creep had either proceeded at a constant fixed rate for at least 200 hours, or until flow had come to a complete stop, at least within the sensitivity of the measuring apparatus, for at least 200 hours. The load on the specimen was then increased and the same procedure repeated.

[1]A. E. White, C. L. Clark & L. Thomassen. An Apparatus for the Determination of Creep at Elevated Temperatures. *A.S.M.E., Fuels and Steam Power*, Vol. 52, No. 27, 1930, page 347.

The "upstep" method of creep testing is not included in the tentative methods proposed by the A.S.T.M.[2] This work was done prior to the promulgation of the A.S.T.M. methods and the data are comparable to earlier data[3] on non-ferrous alloys obtained at the University of Michigan by the "up-step" method.

Creep Test Results

The results of the creep tests on Adnic at 400°, 600°, 800° and 1000°F. are shown in Fig. 12.

Table 4. Creep Characterics of Adnic Metal at Indicated Temperatures as Determined by "Up-step" Loading

Temperature °F.	Stress for Designated Rate of Creep Rate = % per 1000 Hours		
	0.01	0.10	1.00
600	13,800	18,900	25,500
800	4,500	7,900	14,000
1000	630	1,300	2,700

From the above values it is evident that there is a sharp decrease in the load carrying ability as the temperature is increased from 600° to 800°F., but the alloy still retains a fair amount of strength at 800°F. In fact, its load carrying ability at 800°F. is somewhat better than that of plain carbon steel at 1000°F., for the value usually reported for a rate of flow of 0.01% per 1000 hours for carbon steel at 1000°F. is about 3,500 lbs.

At 1000°F. there is a further sharp decrease in the load carrying ability and it is doubtful if this material can be successfully used at this temperature except in cases where the stress is unusually low, or where a large amount of deformation can be allowed.

Although creep tests were also conducted on this material at 400°F. it was impossible to include the results from the tests at this temperature in this table, at least over the stress range considered. In other words, at 400°F., the elastic plus plastic deformation occurred immediately upon the application of the load, or within a relatively short time afterwards, and then creep came to a complete stop, at least within the sensitivity of the equipment used.

In Fig. 13, the results are plotted on logarithmic co-ordinates, that is, the stress is plotted vertically, and the rate of creep produced by that stress, is plotted horizontally. Such a system of plotting is useful in that for certain stress ranges, and at certain temperatures, a straight line relationship is obtained. It is thus easy to determine for a given temperature, the rate of creep produced by any given stress, and likewise to determine the stress required to produce any rate of creep.

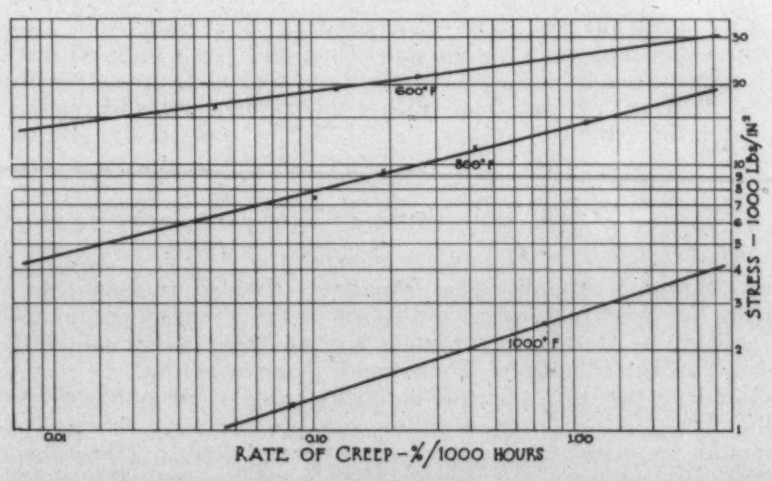

Fig. 13. Creep—Stress Diagram of Adnic Metal at 600°, 800° and 1000° F

[2]Report of Joint Research Committee on Effect of Temperature on the Properties of Metals, *A.S.T.M. Preprint* No. 23, 1933, pages 26-34.

[3]A. E. White & C. L. Clark. Discussion. Symposium on Effect of Temperature on Metals. *A.S.T.M.-A.S.M.E.* 1931, pages 365-266.

The Joint Research Committee on Effect of Temperature on Properties of Metals Announce Creep Test Calibration Bar

The Joint Research Committee of the A. S. T. M. and A. S. M. E. on Effect of Temperature on the Properties of Metals last year prepared tentative "codes of recommended practice" for the making of short-time high-temperature tensile tests, and long-time or "creep-tests." Adherence to the principles described in these codes bids fair to enable different laboratories to secure consistent and reliable results.

In order that such consistency may be demonstrated, and in order to aid laboratories in achieving consistency, there has been a demand for a "standard" material to use in cross-checking results from different laboratories. To meet this demand the Joint Committee is having prepared, through the courtesy of the Bethlehem Steel Corporation, a supply of 0.40% carbon open-hearth steel, specially made, selected, annealed and tested so that the supply is of an extreme degree of uniformity, and thus suitable for cross-checking or so-called "calibration bar" purposes.

The Joint Committee will supply this steel to those laboratories interested in finding out how well their short-time and/or creep tests agree with those from other laboratories. Such cooperating laboratories will agree to make the comparison creep tests at one temperature and load and for the length of time selected by the committee, and the short-time tests at a few selected temperatures, recording all the data required by the codes in order to show that at least the minimum precautions for accuracy required by the codes have been observed. Sufficient material for duplicate tests will be supplied if desired. The A. S. T. M. headquarters can supply at nominal cost pads of forms for reporting data, which workers in this field will find convenient not only for this report, but for regular use.

The results will be summarized and when enough data are in, published, each laboratory being designated only by a symbol.

It is expected that the degree of concordance that will be shown by such a comparison will greatly increase the confidence of engineers in the determinations of high-temperature properties of metals made with modern equipment and using up-to-date precautions for accuracy.

The committee would like to have a list of the laboratories equipped to make short and long-time high-temperature tests under code refinements and the number of creep units that come within the code requirement available in each laboratory. It is desired to list in this "census" both the private laboratories of firms handling only the work of those firms themselves and the research laboratories that can handle such tasks for those whose own research laboratories are not so equipped. It is desired that apparatus and methods being used for study of the possible future applicability to high-temperature investigations of so-called "accelerated" methods be also listed.

Such a "census" will give a mailing list for announcements of matters of interest that the Joint Committee may wish to call to the attention of such laboratories from time to time.

The question of a possible future investigation of the relationship of "accelerated" tests to the regular single load, single temperature, long-time test and of various methods of interpolation and extrapolation from creep data to other loads, other temperatures and other times, on which question the committee recently asked for comment from the industries concerned with the use of metals and alloys at high temperatures, was discussed at its recent meeting. Further comment is desired before the committe makes definite plans. A full statement of this problem has been prepared and can be obtained from the Secretary of the Joint Committee, Mr. N. L. Mochel, Westinghouse Electric & Mfg. Co., Lester Sta., Philadelphia, Pa.

Requests for the steel to be used as "calibration bars" for cross-checking purposes on short-time and creep tests with information on the amount required, as well as information for the "census" of high-temperature laboratories able to operate under the committee codes, should also be sent to Mr. Mochel.

A. I. M. E. Institute of Metals Award

The Institute of Metals Division of the American Institute of Mining & Metallurgical Engineers decided to establish a prize for research papers published in the Transactions of the Institute of Metals. Accordingly a committee was appointed to draw up the conditions. These conditions stated that the paper should be the best scientific or engineering paper published in the Transactions over a three-year period; that the award should be made every year; that no restrictions other than these be put upon the award. The award for 1933 was made by a committee, headed by Prof. Mathewson, Yale University, which selected the paper entitled "Studies Upon the Widmanstätten Structure, I.—Introduction. The Aluminum-Silver System and the Copper-Silicon System," by R. F. Mehl and C. S. Barrett.

Pennsylvania Inter Chapter Meeting of the American Society for Metals

The four Pennsylvania chapters and the Southern Tier Chapter of the American Society for Metals (formerly American Society for Steel Treating) will unite in an inter chapter meeting at State College, Pennsylvania, May 4th and 5th. Members of the society and their friends will be the guests of the Pennsylvania State College and the meetings will be held in the Mineral Industries Building of the college.

A program has been arranged with papers sponsored by each of the five chapters and by the Department of Metallurgy of the college.

Bundy Tubing Subsidiary

Bundy Tubing Company announce the organization of a subsidiary company known as H. W. Bundy, Inc. The new company was incorporated on February 6th with officers as follows: W. W. Anderson, president; T. M. Rude, vice-president; A. C. Winger, secretary and treasurer, and H. J. Blair, superintendent. The new company will take over the commercial parts copper-hydrogen-electric-welding production of the parent company other than tubing. Production includes both custom hydrogen-welding of parts supplied by other manufacturers ready for welding, and also the company production of finished products. General offices will be maintained in the plant of the Bundy Tubing Company at 10951 Hern Avenue. Manufacturing will be done at the former Bundy Tubing Company plant, 4815 Bellevue Avenue, where the company's large "Zeppelin" type hydrogen-welding furnace is located.

Edward T. Gushee, Vice-President and Treasurer of the Detroit Electric Furnace Co. of Detroit, Mich., U. S. A., is sailing for a two months visit to Europe in May of this year. As a result of the rise in interest of electric cast iron in the United States, which has provoked a considerable interest in England, France and Italy, Mr. Gushee is making a trip to study market possibilities and perhaps make an arrangement for sales representation of his company's products which include a line of rocking indirect arc electric furnaces for melting brass, iron and alloy steel.

Harold W. Faint has been appointed to the sales engineering staff of Udylite Process Co. His headquarters will be the Chicago office of the company. He is by no means a stranger to the electroplating industry, coming as he does from a "plating" family. Before the days of modern generators, his grandfather used storage batteries in his plating business in London, England. His father's entire career has been devoted to electroplating, having been foreman plater for Singer Sewing Machine Company for a number of years and later having the same position at International Motors Corp., Allentown, Pa.

Wheeling Steel Corporation, Wheeling, West Virginia, has been elected to membership in the Association of National Advertisers, Inc. J. L. Grimes, General Advertising Manager of the company, will represent them in the A. N. A.

Harold B. Ressler, Vice-President in charge of sales of Joseph T. Reyerson & Son, Inc. at Chicago, will move to New York to take charge of their Jersey City plant, and will maintain a close contact with the other eastern Ryerson plants at Buffalo, Philadelphia and Boston.

Everett Chapman, who joined Lukenweld, Inc., division of Lukens Steel Company, Coatesville, Pa., early in 1930 as Director of Engineering and Research, has been elected Vice-President.

Maxfield Pease, 4614 Prospect Ave., Cleveland, Ohio, has been appointed exclusive sales representative for the entire Northern Ohio territory covering "Falcon" industrial electric heating specialties, manufactured by H. O. Swoboda, Inc., Pittsburgh, Pa.

C. O. Anderson, formerly with Leeds & Northrup Co., and more recently with the Claud S. Gordon Co., of Chicago, has recently been elected Vice-President and appointed General Manager of Pyrometer Service & Supply Corporation, located at 1988 E. 66th St., Cleveland, Ohio, a subsidiary of Claud S. Gordon Company.

Harvey Dieterich, Manager of the Structural Department of Joseph T. Ryerson & Son, Inc., has been made Assistant Vice-President in charge of the operations of the Structural and Special Order Departments in Chicago. Mr. Dieterich has been with the company for 30 years and is one of the most experienced and widely known men in the structural field.

Ainslie Y. Sawyer has been appointed Assistant General Manager of Sales. He has been with the Ryerson Company for 25 years. Mr. Sawyer has served in almost every division of the Sales Department from Manager of the Export Materials Department to Manager of the Cold Finished Steel Division. Recently, however, he has devoted the principal share of his time to the Cold Finished Steel Division.

Herman F. Kluender has been made Vice-President of the Detroit Alloy Steel Company.

ORE CONCENTRATION (1)

JOHN ATTWOOD, SECTION EDITOR

The Development of Mining and Treatment of Copper Ores at Mt. Lyell, Tasmania. R. M. MURRAY. *Chemical Engineering & Mining Review*, Vol. 26, Oct. 5, 1933, pages 5-10. A review showing that complex siliceous ores may now be treated profitably, with the same Cu content (2.5%) as the pyrite ores of 25 years ago. WHBp (1)

Determination by Calculation of Curves for Ore Dressing (Rechnerische Ermittlung der Aufbereitungskurven) J. FINKEY. *Glückauf*, Vol. 69, June 30, 1933, pages 577-582. The formulas of Hancock and Huber-Panu for determining the output of ores are discussed theoretically and checked by experiment. It is found that they have little practical value and are not valid except under quite definite conditions. Ha (1)

Crushing, Grinding & Plant Handling (1a)

Economy in Crushing Plants. G. J. BROWN. *Crushing & Grinding*, Vol. 2, Nov.-Dec. 1933, pages 83-85. Advantages and disadvantages of jaw-type crushers are compared with gyratories. Secondary crushers and their operation are discussed. AHEp (1a)

Explosive Shattering of Minerals. R. S. DEAN & JOHN GROSS. *United States Bureau of Mines, Report of Investigations* No. 3201, Feb. 1933, 19 pages. Effect of spalling is practically nil. Impact is a factor but not the determining one. Casual cracks and pores are not sufficient to explain action of explosive shattering. Explosive shattering probably is related to aggregate structure, and offers a unique method for uncovering some substance held in planes of secondary structure, as Au in pyrite. A pressure of 150 lbs. is an average economical one. Differential shattering is effective with a number of ores. AHE (1a)

Dewatering of Piled Concentrates (Undersokningar rorande avvattningen av sliger i sligupplag) GUST G. BRING. *Jernkontorets Annaler*, Vol. 117, July 1933, pages 335-397. In Sweden wet Fe ore concentrates are piled up at the plants before shipment. During storage the original 8-12% moisture drops to 2-7%. Laboratory tests confirm the opinion that the laws governing this loss are the same as those for capillary water in the ground. Two definite zones of water were found, namely an upper one with mainly air but some water in the capillary pores and a lower one with capillaries nearly filled with water. The height of the lower zone varies with fineness of concentrate, and with degree of compression. Lower zones as high as 246 cm. were found in magnetite concentrates which were 66.5% below 200 mesh. Since the height of the lower zone is constant for a given concentrate, a high pile will have a lower overall moisture content than one which is spread out. A bed of very fine material under the concentrate may draw out the capillary water to a very large extent. Flotation reagents such as pine oil which lower the surface tension of water may also facilitate the dewatering process. 28 references. HCD (1a)

New Possibilities of Crushing Ores (Neue Möglichkeiten zur Aufschliessung von Erzen) L. KRAEBER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, July 30, 1933, page 411. The common methods of crushing ores and 3 newer methods are discussed. The most advantageous one is based on the fact that ores falling on hard surfaces disintegrate into their natural components if these components have different elasticity. Ore is dropped on hard plates from a height of from 6-8 m. Tests still in progress are to be reported in detail later in *Mitteilungen aus dem Kaiser Wilhelm Institut für Eisenforschung.* GN (1a)

Gravity Concentration (1b)

Separation of Minerals by Density Difference. A. A. HIRST. *Iron & Coal Trades Review*, Vol. 27, July 7, 1933, page 16. The principles involved in the stratification induced in a bed of particles by the passage of an upward current of air or water were investigated theoretically and experimentally. The law of Rittinger is not applicable as it does not explain the ratio of sizes which can be treated in practice, and the law of Munroe based on interstitial currents can be employed only by making false assumptions. Under free-settling conditions the size ratios of particles in equilibrium with respect to a pulsating current are not substantially greater than for a continuous current. In practical bed-type separators (wet and dry) the use of pulsating current is advantageous. The great diversity of factors in stratification, as jigging, size and coherence of particles, depth of bed, etc., are fully considered. Ha (1b)

Flotation (1c)

Enrichment of Khenifra Iron Ore (Note sur le probleme d'enrichissement du minerais de fer de Khenifra (Maroc francais) P. E. HENRY. *Annales des Mines*, Series 13, Part 3, Vol. 3, 1933, pages 67-111, 169-231, 277-306, 351-412. Khenifra deposit of iron ore is in French Morocco, 160 kilometers from coast, must be transported 307 kilometers before it reaches Casablanca. It contains about 30 million tons of ore averaging 42.8% Fe, 9.6% Si and 14.6% barytes. A very long series of experiments was conducted both in Europe and United States for elimination of S and raising Fe content of the ore. Ba and Si content had to be cut down. Washing in Hancock jig appears to be the best of the straight washing methods, producing concentrates with 0.5% S and about 3% BaO in the sinter and recovering 90% Fe. Magnetic separation drops S to 0.6-0.7%, recovering 90% Fe and removing a part of SiO_2. Flotation with corn-oil soap reduces S to 0.3-0.4% and sintering of the pulp cuts it down to 0.1%, solving the problem. Refloating barytes with about one kg./t. of corn oil soap gives 98.9% pure $BaSO_4$. Grinding to 0.15 mm. and magnetic separation after flotation reduces SiO_2 to produce marketable sinter. S alone can be eliminated by usual sintering. JDGp (1c)

The Practice of Flotation. G. B. O'MALLEY. *Chemical Engineering & Mining Review*, Vol. 26, Oct. 5, 1933, pages 46-49. A review dealing with the flotability of minerals, and flotation reagents for conditioning, collecting, frothing, depressing, and activating. WHBp (1c)

Milling Methods and Costs at the Alaska Mine Flotation Plant of the Southern Rhodesia Base Metals Corporation, Limited, Southern Rhodesia. C. P. MCMILLIN. *Bulletin Institution Mining & Metallurgy*, No. 349, Oct. 1933, 15 pages; discussion, No. 350, Nov. 1933, pages 15-23. The ore treated is malachite and chrysocolla in the oxidized zone and chalcocite with an occasional speck of chalcopyrite and pyrite in the sulphide zone. Native Cu also occurs. For the year ending March 31, 1931, heads averaged Cu 3.31%, Ag 10.3 dwt./ton. By flotation, 81.4% of the Cu and 82.6% of the Ag are recovered in a concentrate assaying 68.2% Cu and 215.3 dwt. Ag; the tailings carry Cu 0.64% and Ag 1.87 dwt. Reagent consumption is xanthate 0.356 lb./ton, cresol 0.186 lb., tar oil 0.256 lb., and creosote 0.108 lb. Total costs were 79.49 d. AHEp (1c)

Milling Methods and Cost at the Concentrator of the Mount Isa Mine Ltd., Mount Isa, Q. L. K. JACOBSEN. *Proceedings Australasian Institute of Mining & Metallurgy*, No. 90, June 30, 1933, pages 191-225. The ores are complex mixtures of Pb, Zn, Fe and Ag in oxidized, semi-oxidized and sulfide form. A Pb concentrate is made by tabling, midlings being retabled. Tailings are reground and floated using, per ton of ore: secondary ball mill—thiocarbanilide 0.10; first series conditioning tanks—Na_2S 4.00, ethyl xanthate 0.20, Aerofloat No. 25 0.10; second series conditioning tanks—Na_2S 1.00, ethyl xanthate 0.20, Aerofloat 0.02 lb. For 1931-2, ore assayed Ag 5.5 oz., Pb 10.7% and Zn 4.1%. Pb concentrate assayed Ag 21.9 oz., Pb 44.4% and Zn 5.5%. Tailings contained Ag 1.6 oz., Pb 2.6% and Zn 3.8%. Recoveries were Ag 77.1, Pb 80.1, and Zn 25.7%. Costs totaled 31.1330 s./ton concentrates. AHEp (1c)

Bralorne Mill of Bralorne Mines, Limited. FRED E. GRAY. *Canadian Mining & Metallurgical Bulletin* No. 259, Nov. 1933, pages 683-686. A Au-bearing (75-80% free) quartz containing a very small amount of Ag is passed over blankets and the tails floated. Amalgamation (traps and blankets) recovers 74% of the Au and flotation 21% more. AHEp (1c)

1 **Milling Methods at the Oxide Concentrator of the International Smelting Co., Tooele, Utah.** J. J. BEAN. *United States Bureau of Mines, Information Circular* No. 6759, Dec. 1933, 8 pages. Siliceous oxidized Pb ores are concentrated by flotation. The flow sheet is described. In Sept. 1930, heads assayed Cu 0.18%, Pb 18.43%, Fe 7.32%, insoluble 56.35%, Au 0.0567 oz. and Ag 24.85 oz./ton. The Pb concentrate assayed Cu 0.36%, Pb 47.02%, Fe 13.94%, insoluble 16.73%, Au 0.114 oz. and Ag 58.76 oz. and contained 94.6% of the Pb, 43.7% of the Fe, 74.6% of the Au and 87.7% of the Ag. The tailing assayed Cu 0.08%, Pb 1.58%, Fe 6.65%, insoluble 79.69%, Au 0.023 oz. and Ag 4.87 oz. Reagent consumption was Na amyl xanthate 1.5, Na_2S 6.0, Na silicate 4.0, ethyl xanthate 1.2, and pentasol (frother) 0.30 lb./ton. AHEp (1c)

2 **Unusual Minerals in Flotation Products at Cananea Mill Studied Quantitatively by Microscope.** A. M. GAUDIN. *Engineering & Mining Journal*, Vol. 134, Dec. 1933, pages 523-527. A new ore body containing considerable covellite has been developed at the property of the Cananea Consolidated Copper Co's. property near Cananea, Sonora, Mexico. In studying the floatability of this Cu mineral, other minerals of the enargite and tetrahedrite groups were observed together with molybdenite. The latter may prove valuable as a by-product. The following minerals were recorded: silicate, molybdenite, pyrite, chalcopyrite, bornite, covellite, "gray Cu," and sphalerite. "Silicate" covered all the translucent gangue minerals. Identification of each mineral by microscopic examination is explained. WHB (1c)

3 **The Theory of Flotation (Zur Theorie der Flotation)** K. KELLERMANN. *Kolloid Zeitschrift*, Vol. 63, May 1933, pages 220-226. The theoretical views on the principles of flotation processes are reviewed and the action of different chemicals used in the process discussed. The views so far held must be revised on account of the recent investigations in surface action and adsorption phenomena. Ha (1c)

Surface Actions of some Sulfur-Bearing Organic Compounds on some Finely-Ground Sulfide Minerals. A. M. GAUDIN & WALTER D. WILKINSON. *Journal of Physical Chemistry*, Vol. 37, Oct. 1933, pages 833-845. Galena reacts with xanthates to form Pb xanthates, principally by metathesis of oxidized coatings with the xanthate. Subsequently the xanthate changes to sulphur and unidentified oils. Some of the changes appear to require atmospheric oxygen. Because of the great area over which the Pb xanthate or dixanthogen is assumed to be spread, the galena
4 may well be regarded as a catalyst in the decomposition of the primary reaction product. Galena abstracts dixanthogen from aqueous suspension, and apparently catalyzes the decomposition or oxidation of the dixanthogen to yield principally elemental sulphur, pyrite, or ferric iron derived from it by oxidation, changes xanthate to dixanthogen; the dixanthogen can be extracted from the mineral surface provided oxidation of the dixanthogen is prevented. If oxidation at the surface of pyrite is not restricted, the dixanthogen formed there by preliminary oxidation of xanthate, or that abstracted directly from a suspension of dixanthogen, breaks down to elemental sulphur and miscellaneous volatile compounds. Reactions of the Cu and Zn sulphides appear to be different from those of galena and pyrite. In general, indeed, it may be said that each mineral-reagent combination requires a special investigation. EF (1c)

5 **Physico-Chemical Studies of Froth Destruction in Flotation.** N. M. LUBMAN. *Tzvetnuie Metallui*, July-Aug. 1932, pages 28-42. The author studied experimentally the destruction of the two-phase and the three-phase (mineralized) froth by means of eliminating the frother from adsorption layers on the froth films with reagents of greater surface activity and smaller surface tension. As the destruction layers were used iso-amyl alcohol, ethyl acetate, ethyl ether of ethyl malonic acid, and as frothers were used typical flotation reagents such as terpineol, toluidine, and meta-cresol. The surface tension of films, determined by their resistance to rupture, is connected with the stability and conditions of destruction of the froth. The isotherms and the curves of kinetics of surface tension were determined for a series of surface active substances of both classes using the method of float, and membrane effect. In order to determine molecular kinetic mechanism of froth
6 destruction an investigation was made of the action of amyl alcohol on the surface tension of saponin. It was found that very small concentrations of amyl alcohol lower the tension of the surface film of the solution to nil. Since mineral particles possess the property of strengthening the three-phase froth, it can be easily destroyed by adding flotation poisons—protective colloids. The latter by themselves form a stable froth, but in this case act destructively because they expell the reinforcing mineral particles from the froth. BND (1c)

Magnetic Separation (1d)

7 **Investigations of the Magnetic Roasting of Oxide Iron Ores by Means of Brown Ore (Untersuchungen über die magnetische Röstung mit Hilfe von Eisenspat)** W. LUYKEN & L. KRAEBER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung*, Vol. 15, No. 12, 1933, pages 149-160. After a brief review of the methods used so far for the magnetic roasting of ores, that is to transform weakly magnetic ores into strongly magnetizable ones, a new method is described by which Fe ores are converted into the ferro-magnetic form Fe_2O_3 of the iron oxide; this is obtained by reducing the material and then oxidizing it again under suitable conditions. This process has several advantages as the ferromagnetic oxide can be magnetized better and more uniformly with lower magnetizing energy than magnetite. A still better effect in the magnetic ores has lately been obtained by heating the ores together with carbonaceous Fe ores with the exclusion of air.
8 This process is thoroughly studied and described (D.R.P. No. 535,640, 1931). It is found that Fe_2O_3 is completely converted into Fe_3O_4 when brown ore was added in such amounts that molecular ratio $FeCO_3$:Fe_2O_3 existed. Mn enters isomorphously into Fe_3O_4. Further tests have shown that the reducing power of the brown ore can be inhibited by presence of Mn oxides giving off O to such an extent, according to the ratio of mixture, that no trace of FeO could be found; in spite of this the samples were magnetic, very likely due to formation of manganoferrite and ferromagnetic Fe_2O_3. The concentration can be considerably improved by this method of roasting with brown ore. The addition of 250 g. brown ore to 1000 g. hematite increased the output of metal from 22.5 to 69.7% and with 500 g. to 1000 g. hematite a little more while the output in concentrates increased
9 from 25.4 to 53.4% respectively. Ha (1d)

Amalgamation, Cyanidation & Leaching (1e)

Removal of Selenium and Tellurium from Copper Electrolysis Mud (Über die Entfernung von Selen und Tellur aus Kupferelektrolyseschlammen) MAX HERBERLEIN. *Metall und Erz*, Vol. 30, Sept. 1933, pages 363-366. Se and Te contained in Cu ores remains with the Cu through the smelting and converting processes and must be removed from the electrolysis mud. They occur in the mud as Cu_2Se, CuSe, Ag_2Te, and $AuTe_2$. During roasting they are partly oxidized and appear in the roasted product as $2CuO{:}SeO_2$ or $CuO{:}SeO_2$ and TeO_3. The solubility of Se and Te compounds in H_2O and other solvents and the heats of formation
10 were determined. The best process for removing Se and Te is to roast the mud and leach it in boiling saturated KOH solution. This dissolves all the Se, up to 70% of the Te, and a slight amount of As and Sb. Some colloidal Au is lost. The roasting must be complete. The residue is washed and neutralized with H_2SO_4 and contains about 1% Se and less than 1% Te. By neutralizing the leached solution with H_2SO_4, TeO_2 is precipitated, and by adding 10% excess H_2SO_4 and treating with SO_2, Se is precipitated. Both can be marketed. 4 references. CEM (1e)

ORE REDUCTION (2)

A. H. EMERY, SECTION EDITOR

Non-Ferrous (2a)

An Experimental Combination of Shaft Roasting and Reverberatory Smelting. FREDERICK LAIST & J. P. COOPER. *American Institute Mining & Metallurgical Engineers,* Technical Publication No. 510, Nov. 1933, 8 pages. A flotation Cu concentrate was roasted by dropping down a heated shaft with flux, directly into a reverberatory furnace 3 ft. wide and 21 ft. long. The roasting shaft was 3 ft. square, and had an effective height of 20 ft. The furnace was heated with oil. The shaft increased the smelting capacity 2½ times and decreased fuel consumption per ton of charge 60 per cent. The amount of Cu in the dust was not excessive. The effectiveness of the shaft would not be as pronounced with a large furnace on account of its higher fuel efficiency. JLGp (2a)

Making of Beryllium (Über die Darstellung von Beryllium) H. E. MARTENS. *Die Metallbörse,* Vol. 23, Aug. 19, 1933, pages 1054-1055. Experiments of Borchers, Graetz, Liebmann, Meyer & Hopkins, Stock-Goldschmidt, Lebeau, Dickinson & Vivian, and Vivian are reviewed historically. The electrolysis of Stock-Goldschmidt originally was accomplished at 1290° C. in melts of $NaBeF_3$, $BaBeF_4$ and $BaBeF_6$ using a C crucible (anode) provided with a Swedish wrought Fe cathode. A method is described using a mixture of Be oxy-fluoride and Ba fluoride. Present price of Be is 1 kg—600 R.M. EF (2a)

Production and Deposition of Indium. WILLIAM S. MURRAY. *Industrial & Engineering Chemistry; News Edition,* Vol. 11, Oct. 20, 1933, page 300. In is produced by flotation, roasting of the concentrate, leaching the calcine with H_2SO_4 and throwing out the In by metallic replacement or by neutralization. The impure precipitate is dissolved, purified and plated out of solution. A typical cyanide plating bath is: 5 oz. In as double cyanide, 9 oz. free cyanide or equivalent amount of NaCN, 2.5 oz. sugar made to 1 gal. The deposit of In is soft, uniform and gray. WHB (2a)

Technical Electrolysis of Fused Salts. Vol. III of Engelhardt's Handbook of Technical Electrochemistry (Handbuch der technischen elektrochemie. Band III. Die technische Elektrolyse im Schmelzfluss) Edited by V. ENGELHARDT. Akademische Verlagsgesellschaft, Leipzig, 1934. Cloth, 6½x9¾ inches, 561 pages. Price 52 RM.

Ten different authors prepared different sections of this book.

After a brief discussion of the theory of fused-salt electrolysis, the smelting of the metals thus obtained is described in detail. The various processes used or suggested for production of Na, K, Li, Rb, Cs, Ca, Sr, Ba, Mg, Al, Be and the Ce group are discussed, with brief comment on heavy metals that can be thus prepared.

The treatment is historical, early and abandoned methods, as well as some of those that never got beyond the patent stage being included, many of the illustrations being taken from patents and the copious references including many patents. However, the commercially satisfactory processes are emphasized so that the reader is seldom left in doubt whether a process is merely included for sake of historical completeness.

Most space is given to Al, Be and Mg. Some mention is made of uses for the various metals, particularly Ca, Be and Mg, though the properties of the alloys of the various light metals are not taken up in much detail. Very detailed discussion of the preparation of the electrolytes and of the electrolytic processes is the rule. Preparation of carbon anodes for aluminum is given considerable attention.

The book is excellent for reference purposes, well printed and well indexed.

H. W. Gillett (2a)-B-

Studies on Kernel Roasting. T. KIMURA. *Journal Mining Institute of Japan,* Vol. 48, Dec. 1932, pages 1275-1288. Mechanism of Cu enrichment in the kernel during roasting of chalcopyrite was studied. The composition changes with the progress of the roasting in the order: chalcopyrite-bornite solid solution, bornite, bornite-chalcocite solid solution, and chalcocite. The Cu sulphide liberated by the oxidation of the Fe sulphide diffuses into the unroasted portion so that Cu gradually concentrates in the kernel. A layer of Cu ferrite is produced on the surface, retarding greatly further progress of roasting. The magnetic property of the kernel is due to this Cu ferrite layer. YO (2a)

Reduction of Copper Oxide by Carbon Monoxide and Hydrogen (Etude de la Reduction de l'Oxyde de Cuivre par l'Oxyde de Carbone at l'Hydrogène) A. JULIARD. *Bulletin de la Societe Chimique de Belgique,* Vol. 41, Feb. 1932, pages 65-84; Mar. 1932, pages 138-151; May 1932, pages 234-247; June 1932, pages 289-308. The possibility of reducing CuO by CO and H and the influence of the amount and nature of CuO and temperature on the velocity of reaction was investigated on a laboratory scale. H and CO reduced powdered CuO with an appreciable speed beginning at 100° C. These reactions are auto-catalytic; the reduction starts only after a certain period of induction which can be shortened materially by adding metallic Cu to the oxide. The reaction products (CO_2 or H_2O vapor) and O retard the reaction. The velocity of reaction increases rapidly with time after the induction period, reaches a maximum and then diminishes. The total time of reduction decreases when the temperature is raised from 100 to 250° C. and the time is shorter with CO than with H. The theory of, and heat balances of, the processes are derived. Ha (2a)

Sintering and Smelting Mixed Lead Carbonate-Lead Sulphide Concentrates at Mt. Isa, Queensland. F. A. FORWARD. *Proceedings Australasian Institute of Mining and Metallurgy,* No. 90, June 30, 1933, pages 125-189. The plant is described exhaustively. AHEp (2a)

The Recovery of Zinc and Lead from Blast-Furnace Slag at Trail, B. C. G. E. MURRAY. *Transactions Canadian Institute of Mining & Metallurgy, 1933 (in Canadian Mining & Metallurgical Bulletin* No. 260, Dec.) pages 562-565. Discussion. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 371. AHE (2a)

Silicon Carbide, Its Production and the Manufacture of Rods (Siliziumkarbid, seine Gewinnung und die Herstellung der Stäbe) L. NAWO. *Elektrowärme,* Vol. 3, Apr. 1933, pages 82-84. Resistance material of SiC is in successful use for temperatures up to 1500° C. (2730° F.) Quartz sand and powdered coke are mixed with some sawdust and NaCl, and at about 1900° C. the reaction $SiO_2 + 3C = SiC + 2CO$ takes place. Pure SiC is colorless, of hexagonal crystal structure and does not melt at atmospheric pressure. Commercial SiC contains impurities of Al and Fe and is greenish to black in color. It is not attacked by O up to 1000° C.; from 1350° to 1500° C. it oxidizes to fused SiO_2. Metal oxides are reduced by SiC-CuO at 800° C., Fe_2O_3 and Ni oxide at 1300°, Mn oxide at 1360°, Cr oxide at 1370° C. Acids do not attack SiC, but it reacts with alkalies, potash, molten soda and borax. Cl acts at 600° C. only on the surface, at 1200° completely. At 2200° C., SiC disintegrates into its elements. The formation of heating elements, especially the proper preparation of the ends for connection to cables and arrangement of water cooling is described and illustrated. Ha (2a)

Ferrous (2b)

Recent Developments in American Blast Furnace Design and Practice. WILLIAM A. HAVEN. *Blast Furnace & Steel Plant,* Vol. 21, July 1933, pages 364-367; Aug. 1933, pages 415-418; Sept. 1933, pages 480-482; *Engineering,* Vol. 135, May 5, 1933, pages 501-504. See *Metals & Alloys,* Nov. 1933, page MA 371. MS+LFM (2b)

1

The Specific Efficiency of the Blast Furnace (Die spezifische Leistung des Hochofens) DÁNIEL VON DIÓSZEGHY. *Feuerungstechnik,* Vol. 21, July 15, 1933, pages 102-104. The service data given in literature on 280 blast furnaces are evaluated. Diameter of hearth is plotted against (1) total C combustion in 24 hrs., (2) specific C combustion in tons/m.²/day, (3) charge melted down in tons/24 hrs. and (4) specific melting efficiency in tons/m.² hearth area/24 hrs. The hearth diameters varied from 1.7 m. to 6.79 m. The furnaces operate with 36 to 150% slag. The specific melting efficiency of a blast furnace with reference to the output of pig Fe + slag and the melting efficiency referred to 1 ton of C reaches a maximum at a hearth diameter of 5.0-5.5 m. EFp (2b)

2

The External Heat Loss of a Blast Furnace. D. F. MARSHALL. *Iron & Coal Trades Review,* Vol. 126, May 5, 1933, pages 685-688. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 371. Ha (2b)

Some Theoretical Considerations Regarding the Use of Oxygen Enriched Blast in Blast Furnaces. N. A. KOSTYLEV. *Domez,* No. 8, 1933, pages 1-19 (In Russian). From a comprehensive set of data on the performance of a modern blast furnace, the author recalculated the effect of using air enriched with O up to 25%. Addition of O_2 to the blast sharply increases its reducing capacity and the yield, with a consequent reduction of overhead charges. Using 18-22.5% O_2, cold blast may be used and gas with as much as 1500 Cal./m.³ thermal capacity may be produced. O addition allows operation with a cold top, and decreases dust losses. Coke consumption drops 10-12% when O and cold blast are used, but most of the reduction in coke consumption is due to the replacement of limestone with CaO. p (2b)

3

Effect of Blast Regulation on the Working of a Blast Furnace (Einfluss der Windführung auf den Hochofengang) A. MICHEL. *Stahl und Eisen,* Vol. 53, Oct. 19, 1933, pages 1073-1080. With higher blast pressures, the oxidation zone widens; with higher blast temperatures the width and height of the combustion zone diminishes. The oxidation zone becomes wider as the inner diameter of the tuyeres increases, but the height of the oxidation zone is independent of the shape of the tuyeres. A tuyere modification is described whereby the extent of the oxidation zone is changed without varying the air input. In this way the oxidation zone can be regulated to obtain a better utilization of the gases in the furnace and a saving in coke. SEp (2b)

4

Effect of Air Pressure and Temperature on the Oxidation-Zone in the Blast Furnace (Einfluss der Windmenge und Windtemperatur auf die Oxydationszone im Hochofengestell) G. EICHENBERG & W. EILENDER. *Stahl und Eisen,* Vol. 53, Sept. 28, 1933, pages 997-1000. In tests of a blast furnace 4 meters in diameter, increased air pressure widened the zone containing free O_2 and CO_2 toward the center, but did not raise the zone higher in the furnace. During more difficult working of the furnace, this oxidation zone extended further toward the center; lowering the air temperature had the same effect. The significance of the oxidation zone in regard to the performance of the furnace is discussed. SEp (2b)

5

Aluminium Blast Furnace Tuyeres. TOSHIHIKO HIRAKAWA. *Iron & Coal Trades Review.* Vol. 127, July 17, 1933, page 18; *Foundry Trade Journal,* Vol. 49, July 13, 1933, page 23. Experiments in Japanese Steel Works showed that in spite of the higher heat conductivity and melting point of Cu, blast furnace tuyeres made of Al outlasted them and gave 3 times less failures when molten metal Fe comes into contact with them. OWE + Hap (2b)

Reactions in Bosch and Hearth of Blast Furnaces and Its Meaning in the Blast Furnace Process (Verlauf der Vorgänge in der Rast und im Gestell und ihre Bedeutung für den Hochofenprozess) ALFRED MUND, J. STOECKER & W. EILENDER. *Mitteilungen aus dem Institut für Eisenhüttenkunde der Technischen Hochschule Aachen,* Vol. 11 1932, 14 pages. See *Metals & Alloys,* Vol. 3, May 1932, page MA 152. Ha (2b)

6

Gases Generated in Reduction of Iron Oxides with Carbon (Die bei der Eisenoxyde mit Kohlenstoff entstehenden Gase) W. BAUKLOH & G. ZIMMERMANN. *Stahl und Eisen,* Vol. 53, Feb. 16, 1933, pages 172-173. The reaction between C and O in the ore was studied by heating Fe oxide, magnetic ferric oxide and ferrous oxide with fine graphite in a vacuum. Both CO_2 and CO can originate primarily by the reaction of Fe oxides with solid C. Curves showing the content of CO_2 as a function of the duration of the reaction are given. Ha (2b)

The Influence of Manganese upon the Equilibria between Iron Oxides and Carbon Monoxide and Carbon Dioxide respectively at the Thermal Disintegration of Brown Ore (Ueber den Einfluss des Mangans auf die Gleichgewichte zwischen den Eisenoxyden und Kohlenoxyd bezw. Kohlensäure bei der thermischen Zersetzung von Eisenspat) L. KRAEBER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Vol. 15, No. 12, 1933, pages 160-166. Experiments in thermal disintegration of manganiferous $FeCO_3$ showed that free FeO increases with the disintegration temperature if the expelled gas remains in contact with the residue. Chemical and X-ray analyses of roasted samples showed that at 95% CO_2 concentration, the residue contains only an isomorphous mixture of $FeO \cdot Fe_2O_3$ and $MnO \cdot Fe_2O_3$. With more O added, more Fe_3O_4 is reduced to Fe_2O_3 while $MnO \cdot Fe_2O_3$ remains permanent. The Fe_2O_3 formed is cubic and forms other solid solutions with Fe and Mn. The different conditions of CO_2 concentration are investigated and reproduced in tables. 9 references. Ha (2b)

7

8

The Applicability of Low-temperature Reduction to Certain Ontario Iron Ores. J. R. GORDON & O. W. ELLIS. *Canadian Mining & Metallurgical Bulletin* No. 259, Nov. 1933, pages 687-725; discussion No. 260, Dec. 1933, pages 772-774. Detailed data are given on the reducibility, grade of concentrate and recovery of Fe at various temperatures of reduction for various times for various ores ground to various sizes. The highest grade ores were reduced most readily. The order of reducibility is determined chiefly by the quantity, distribution, and character of their impurities. Variations in the size of ore have much less effect on the reducibility of high-grade ores than of low-grade ores. Lengthening the time of reduction is effective only in case of dense impervious ores. Magnetic concentration of the raw ore prior to reduction is preferable to concentration of the material reduced from unconcentrated ores. AHE (2b)

9

Roasting and Reduction of Siderite (Röst- und Reduktionsverhalten von Spateisensteinen) J. KLAERDING. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 207, Aug. 1932, pages 246-250. Reduction of Fe ores of different origin in a CO atmosphere at 900° C. was investigated. In the presence of S the reduction is difficult in spite of a large percentage of Cu present, due to the lowering of the melting point of the ore. Ha (2b)

Variation in Coke Ash Found to Affect Analysis of Pig Iron. H. W. JOHNSON. *Iron Age,* Vol. 131, Apr. 27, 1933, pages 664-665; *Iron & Coal Trades Review,* Vol. 127, Aug. 11, 1933, page 207. Variations in the ash content of coke have an effect on the analysis of pig Fe. Ha + VSP (2b)

10

Coke Consumption in Blast Furnace Practice. D. F. MARSHALL & R. V. WHEELER. *Iron & Coal Trades Review,* Vol. 126, May 5, 1933, pages 680-685; *Engineering,* Vol. 135, May 12, 1933, pages 525-526, 531-532. See *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 371. Ha+LFM (2b)

MELTING, REFINING & CASTING (3)

Temperature Affects Molding Sand. Sixten O. V. Nilsson. *Foundry*, Vol. 61, Mar. 1933, pages 10-12, 44. Behavior of molding sand at casting temperatures plays a more important role than the position of the sintering point, according to investigations of other writers. Sand subjected to strong heat for first time, shows tendency to expand and also such expansion may be expected following reheating. Strongest expansion ordinarily takes place at first heating to over 2372° F. and depends on quartz transforming into tridymite. Heating from 840 to 932° F. bonding clay loses half of its H_2O content and by heating for 1 hr. to 1112° F. all chemically combined H_2O is driven out. In such case clay cannot be made plastic and binding again. Each molding sand demands the completion of the pouring within a certain time, that is before the mold surface is heated to the critical temperature. Scabbing can be checked by mixing sand with materials which shrink when heated. Gives tests. VSPp (3) 1

Controlling Properties of Cores. Harry W. Dietert & Franz von Valtier. *Foundry*, Vol. 61, April 1933, pages 18-19, 50. From a paper read before the Panrussian Scientific Technical Foundrymen's Association, Moscow, Feb. 5-10. Control of physical properties of a core insure better castings at lower loss. Variation in fineness of core sand may cause the strength, permeability, baking time or gas content to change sufficiently to result in scrap producing cores. Tensile strength of core decreases rapidly as surface area of core sand increases. Shape of core sand grains influences strength of core. Round sand grains will give a core strength of 268 lbs. and sharp grains will give a strength of 185 lbs. when other conditions are constant. Time required to bake cores is related to fineness of core sand. Maximum surface hardness of core is secured by a low temperature and long baking time. Gas content of core is a direct measure of core below defect possibility, assuming the mechanical venting remains constant. Quantity of gas given off in mold is proportional to quantity of oil placed in the mix. Moisture content of green core sand mix has great influence on green sand strength and baked strength of core. VSPp (3) 2

Binding of Core Sands (L'Agglomération des Sables à Noyaux) Hervier. *Arts-et-Métiers*, Vol. 85, Dec. 1932, pages 465-466. Qualities of a good binder for core sands are reviewed. It is shown that a careful chemical study of problem is needed. Author concludes from his considerations that a good binder must be composed exclusively of organic matters without mineral salts or acid products and must not contain products called "catalysts" which damage core boxes. Organic matter must consume rapidly under contact with hot metal in order to allow easy shaking of sand out of finished castings, to prevent hot cracks formation which appears when shrinkage is impeded by too hard a core. Linseed oil is a good binder but gives mixtures without green bond. Recently an organic matter made with by-products of sugar refinery has been developed and would answer all requirements explained in the present article. With this binder, tensile strength would be 8 kg./mm.^{2} whereas maximum tensile strength with linseed oil is 6 kg./mm.^{2} in same conditions. Chemical composition is thoroughly known and varies according to kind of sand to be bonded. FRp (3) 3

Bonds Sand Molds with Cement. Vincent Delport. *Foundry*, Vol. 61, June 1933, pages 44-45, 85. Describes a process developed by Compagnie Randupson, Marseille and the Societe d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine, Savoie, France, for making molds and which has as its principle the use of a mixture of sand and cement as molding material. Sand used is pure siliceous material and a high grade of Portland cement in the proportion of 15 parts cement and 100 parts of sand. The % of H_2O with reference to the cement, in vol., should be between 70 and 90% to give best results. Permeability of molds is measured rapidly by a simple apparatus. Strength of sand-cement mixture, when set, is practically independent of ramming of sand during molding. Molds can be made by hand or by machine. Any metals and their alloys may be poured in these molds. VSPp (3) 4

Fire Clay for Follow Boards. Pat Dwyer. *Foundry*, Vol. 61, June 1933, pages 34-35, 71. Describes the method and material used in the construction of fire clay follow boards at the plant of the Eberhard Mfg. Co., Cleveland. This material is adaptable particularly to gates of small and intricate patterns. VSP (3) 5

Humidity and Oil Sand Cores. A. S. Coulter. *Foundry*, Vol. 61, Feb. 1933, pages 13, 52. Discusses result of tests conducted on oil binders to determine what factors are responsible for variations in cores. Linseed oil was used in the tests since it is the accepted standard of all compounded oil binders. Results show that proper conditioning of air passing through core ovens is of importance due to moisture in atmosphere which influences successful drying. VSP (3) 6

Calculation of Patterns (Ueber die Kalkulation von Modellen) Arno. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 15, 1933, pages 433-436. On the base of a few examples, importance of accurate calculation methods of patterns is stressed. Calculations are given for a ring-shaped pattern, a disk pattern and pattern of a joint lever. GN (3) 7

Success of German Patternmaking (Ein Erfolg deutschen Modellbaues) E. Moll. *Die Giesserei*, Vol. 20, July 21, 1933, pages 310-314; Aug. 4, 1933, pages 334-335. Molding machines and equipment are described which were supplied recently to the USSR by German firms. They are mostly for quantity production of intricately shaped parts. Ha (3) 8

Sand Control on a Continuous Molding Unit in a Malleable Foundry. Charles Morrison. *Transactions American Foundrymen's Association*, Vol. 41, 1933, pages 127-143. A description of sand control practiced in a foundry having continuous molding and sand handling equipment and which uses all facing sand. CHL (3) 9

Some Experiences with Routine Sand Testing of Green Sand. John Hird. *Foundry Trade Journal*, Vol. 48, June 22, 1933, page 426-427. An article describing experiences with the Dietert A. F. A. sand-testing apparatus. Information is given on the time taken for making tests on individual sands, accuracy of tests, and effects of sieving on test results. What has been found to be a useful sand-test report form is illustrated. OWE (3) 10

Special Core Molding Machine for Large Intricate Cores (Spezialkernformmaschine zum Herstellen grösserer komplizierter Kerne) Hugo Hollweg. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Nov. 26, 1933, pages 483-486. Author discusses his special core making machine developed for making large cores for automobile crank cases. The construction of the machine is, as far as the lower part is concerned, similar to a turnover molding machine but possesses compressed air lifting device with oil. The advantages of this method are enumerated, high stroke and quiet operation. Chief parts of the equipment are described in detail. Cores made by the machine are more accurate, uniform and by about 50% cheaper than same cores manually molded. GN (3) 11

German Foundry Graphite in Practice (Der deutsche Giessereigraphit in der Praxis) A. Humann. *Die Giesserei*, Vol. 20, Nov. 10, 1933, pages 503-505. German graphite found in Bavaria has a very low S content and the crystalline graphite made from it contains more C than the Bohemian graphite so far used. Preparation for foundry purposes is explained. Ha (3) 12

Questions of Molding Sands (Formsandfragen) Karl v. Gienant. *Die Giesserei*, Vol. 20, July 7, 1933, page 287. Colloidal constituents play an important part in quality of a molding sand. The reason that molds in America are much more loosely tamped than in Germany and yet give good castings is ascribed to differences in colloidal conditions which should be investigated. Ha (3) 13

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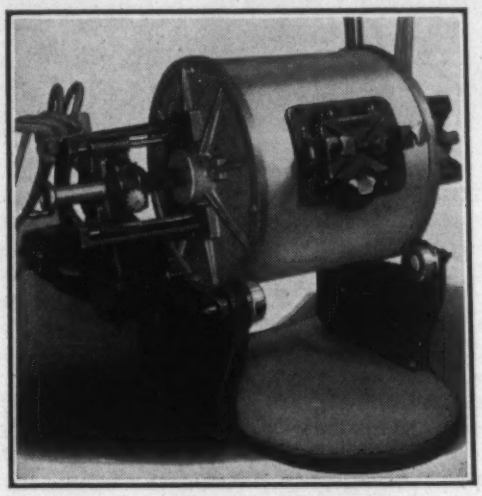

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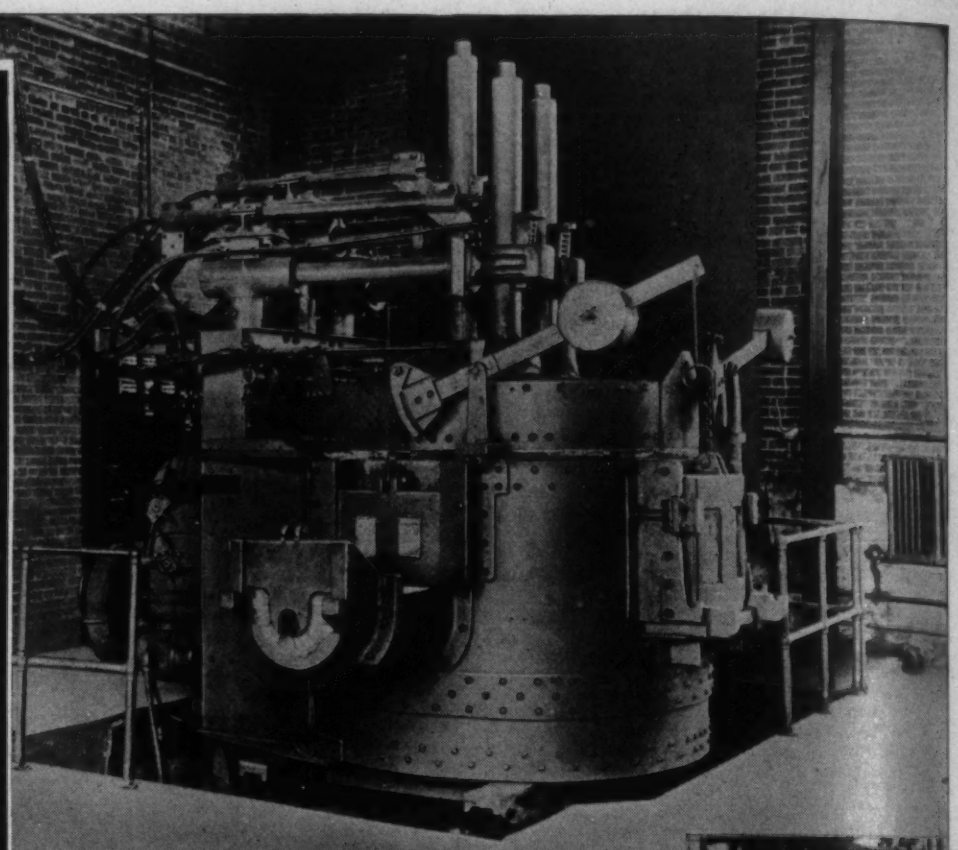

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Monorail Materials Handling in the Foundry. J. B. FORKER. *Mechanical Handling & Works Equipment*, Vol. 20, Apr. 1933, pages 117-120. See *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 297. JCC (3)

Prevent Losses With Proper Gates and Risers. PAT DWYER. *Foundry*, Vol. 60, Nov. 1932, pages 39-40, 42. Thirty-fifth of a series. Some castings may be poured satisfactorily in vertical position if care is taken. The same casting, in some instances, may be poured in horizontal or slightly slanted position. Illustrates his points. VSP (3)

Prevent Losses With Proper Gates and Risers. PAT DWYER. *Foundry*, Vol. 60, Aug. 1932, pages 38, 40-41. Thirty-second of a series of articles. Defective castings may result from any one of several causes, or a combination of several causes. Sometimes the cause is apparent and may be easily remedied, while in others a process of elimination is required to make sure of the cause. Cold sheets may develop through slow pouring, dull metal, badly designed gates or failure to keep metal moving steadily in mold. Lack of uniformity in metal thickness may cause migration of eutectic from one part to another. Contraction strains may cause metal in certain parts of castings to tear apart. VSP (3)

Important Hints on Construction of Molds (Wichtige Winke für den Ausbau von Formen) HANS ECKART. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, July 23, 1933, pages 300-303. After discussing precautions to be taken in dry and green sand molding in order to obtain smooth castings made with template or pattern the author deals with the use of some special implements to attain this end. GN (3)

Pulverized Coal in Molding Sand (Steinkohlenstaub im Formsand) P. AULICH. *Die Giesserei*, Vol. 19, Nov. 25, 1932, page 484. See *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 298. Ha (3)

Study of Foundry Sands (Introduction à l'etude des Sable de Moulage) L. F. C. GIRARDET. *Bulletin de l'association Technique de Fonderie*, Vol. 7, Feb. 1933, pages 43-58, 60. Deals with condition and uses of sand, its constitution, and methods of testing. 24 references. GTM (3)

Green Sand Casting (Der Metallnassgussspezialist) A. HEINZ. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, July 23, 1933, pages 305-307. Discusses the principal differences in molding and casting of green and dry sand castings. These differences refer to composition of molding sand, ramming of mold, gating, closing of flasks, casting and proper choice of flasks. The discussion goes to show that no specialists are required for green sand molding when the rules given are borne in mind. GN (3)

Mechanical Handling Equipment in Small Foundries. H. L. HOEFMAN. *Mechanical Handling & Works Equipment*, Vol. 20, Jan./Feb. 1933, pages 12, 42-43. From an address before National Founders' Association, New York. Conveying systems for continuous-pouring or intermittent foundries are outlined. Mechanical handling can effect savings in foundries casting as little as 25 tons per day. JCC (3)

Surface Tension of Molten Metals. A. I. KRYNITSKY. *Metals & Alloys*, Vol. 4, June 1933, pages 79-84. A correlated abstract. Conception of surface tension is defined and illustrated. 3 methods of measuring surface tension and the results for different metals are given in tables and graphs. The practical importance of surface tension is its influence on the shrinkage and runability of molten metals in casting, welding, soldering, and joining. Present data is meager, but some work on Al-Cu alloys is given to show the adverse effect of Cu up to 1.5% on runability. Further addition of Cu increases runability as shown by a running quality/concentration diagram. 18 references. WLC (3)

Study of Molding and Core Sands (Etude des Sables de Moulage et de Noyautage) M. GIRAULT. *Revue de Fonderie Moderne*, Vol. 27, Jan. 25, 1933, pages 23-29. The selection of foundry sands should be based on exact measurements of humidity, permeability and cohesion; test methods and preparation of sand and
6 binder, control methods for maintaining uniformity of product are discussed. Ha (3)

Runners and Risers. T. R. HARRIS. *Foundry Trade Journal*, Vol. 49, Sept. 14, 1933, pages 151-152. General discussion of methods of designing runners and risers for castings of various types, typical examples being quoted and illustrated by diagrams. OWE (3)

— **Application of A.F.A. Sand Testing by the Producer.** C. M. HARDY. *Transactions American Foundrymen's Association*, Vol. 41, 1933, pages 167-174. Since sand deposits vary from layer to layer, those variations must be taken into account in selection and milling of sands to meet shipping requirements. The tolerances allowable for various properties and representative analyses of various types of sands are listed. CHL (3)

7 **Pipes, Blisters, Binders (Soffiature, Anime, Agglomeranti)** M. BARIGOZZI. *L'Industrie Meccanica*, Vol. 15, Apr. 1933, pages 325-329. Investigations showed that high pressure of gas developed from binder in molds favors formation of pipes and blisters in interior of an ingot. Only about 1.85% of binder should be used, and careful attention given to arrangement of vent ducts and risers. 7 references. Ha (3)

— **Humidity of Green Sand (Ueber Rohsand-Feuchtigkeit)** J. BEHR, H. BEHRENDT & W. CLAUS. *Die Giesserei*, Vol. 20, Sept. 15, 1933, page 421. Contents of H_2O in sand increase with the depth from which they are taken, a maximum of 30% has been found. Before they are sold they should be dried as this means a considerable saving in freight for foundries. Ha (3)

8 **A Quick Moulding Job.** J. H. LIST. *Mechanical World & Engineering Record*, Vol. 93, Feb. 24, 1933, page 173. Describes construction of a brick mold to produce a branch piece in 5 days. Kz (3)

Molding in the Foundry (Le Moulage en Fonderie) HENRI TINARD. *Cuivre et Laiton*, Vol. 5, Nov. 30, 1932, pages 531-533. Various processes of molding by hand and machine, preparation of sands, and casting in metal molds is discussed and equipment described. Casting in metal molds has found particular favor for smaller pieces while castings with difficult shapes can not be made in metal molds. Ha (3)

Special Flask for Making Pattern Boards (Spezialformkasten für Modellplattenherstellung) FERD. BROBECK. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, July 23, 1933, pages 309-310. Description of a patented method
9 using flasks that can be subdivided by partitions. GN 3)

Molding Device for Bearing Shields and Similar Patterns (Formeinrichtung für steilwandige Lagerschilder und ähnliche Modelle) F. BROBECK. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Aug. 20, 1933, pages 351-353. In mass production of steep walled bearing shields and similar articles a special molding device is required which the author describes in detail. The molding flasks show some remarkable particularities which are discussed. The accuracy of the flask pins plays an important role for obtaining castings true to dimensions. GN (3)

Oil Core. HACHIE SAWAMOTO. *Suiyokwai-shi*, Vol. 7, Nov. 25, 1932, pages 198-203. Pure silica and such binding materials as core oil and molasses
10 were mixed in various proportions and baked. Bending strength was measured. Best baking temperature in core mixed with oil or molasses was 200° C., and when amount of oil or molasses got beyond a certain amount strength decreased. When oil and clay were mixed together, best baking temperature was 250° C., but it was 170° C. when molasses and clay or molasses, oil and clay were used together. HN (3)

Economical Operating Methods in the Single Manufacture of Large Castings (Wirtschaftliche Arbeitsmethoden bei der Einzelanfertigung grösserer Gussstücke) F. Brobeck. *Die Giesserei*, Vol. 20, Apr. 28, 1933, pages 169-172. It is shown by examples of large castings (5200 mm. long, 600 mm. wide) how proper preparation by the foundry foreman of molds, disposition of work, molding methods, arrangement of gates and risers, can bring down the cost of the piece even if a single piece only is demanded. Ha (3)

New Molding Device for Molding Without Flask (Eine neue Formeinrichtung für kastenloses Formen) R. Berger. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 15, 1933, pages 436-437. Discusses advantages and difficulties encountered in flask-less molding. New molding device, made by Künkel & Wagner, Alfeld/Leine, Germany, is described, eliminating disadvantages of other methods. GN (3)

Chaplets (Altes und Neues über Kernstützen) R. Berger. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 29, 1933, pages 443-444. After discussing disadvantages of other types of chaplets made by riveting together the single parts newer types stamped of one part are described. The "Sonnet" chaplets are particularly referred to. GN (3)

Preparation of Sands in Different Branches of Industry (La Preparation des Sables dans les differentes Branches d'Industrie) H. Behrens. *Revue de Fonderie Moderne*, Vol. 27, July 25, 1933, pages 215-216. A brief discussion of methods of preparing sands for foundries, gas plants, furnaces, etc., and description of equipment. Ha (3)

Mechanical Precision Molding (Le Moulage méchanique de Précision) G. Itam. *Revue de Fonderie Moderne*, Vol. 27, Sept. 25, 1933, pages 255-257. Conditions are discussed which have to be met to produce castings which are as close as possible to required dimensions and in as good condition as possible to require little machining. Ha (3)

Hearth Molding (Das Gebiet der Herdformerei) W. Heidger. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 1, 1933, pages 402-403. Author considers working methods in hearth molding and outlines field of this method. Advantages and disadvantages are dealt with. Pattern costs are low, molding is inexpensive but castings are not highly accurate. GN (3)

Some Practical Applications of Sand Tests (Quelques Applications pratiques des Essais de Sable) G. Henon. *Bulletin de l'Association Technique de Fonderie*, Vol. 7, Dec. 1933, pages 506-513; *Usine*, Vol. 42, Dec. 21, 1933, page 27. Advantages of testing foundry sands is discussed and it is shown by a number of examples that great practical advantages can be derived by it in molding and obtaining good castings. Ha (3)

Experiences in Using "Monolith" for Pattern Boards (Erfahrungen bei der Verwendung von "Monolith" beim Herstellen von Modellplatten) A. Heinz. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 1, 1933, pages 414-416. Author first discusses and compares advantages and disadvantages of metal and gypsum pattern boards. Disadvantages of gypsum boards are eliminated by Monolith boards. Monolith is a cast stone product which neither expands nor shrinks after casting, hardens much better than gypsum, possesses high stability and manifold possibilities of application. Making of Monolith boards is discussed in general, application is outlined in particular. Processing is similar to gypsum boards. As contrasted with gypsum Monolith is not mixed with water but with a special solution. Monolith hardens after 8-10 hrs. Durability of Monolith boards is only surpassed by metal boards. Monolith boards are more economic than metal boards. GN (3)

Spoiled Castings, Size of Gates and Output in Steel Foundries in Making Hollow Castings (Ausschussfragen, Steigergrösse und Ausbringen in Stahlgiessereien für Hohlguss) Walter Kerl. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Sept. 3, 1933, pages 361-364. Author discusses at length various causes of casting defects: (1) porosity, pipes, segregations, etc. (2) slag inclusions, fins, (3) molding defects, distortions of molds and cores (4) distortions and cracks in castings (5) boiling of metal in mold, improper filling of the mold. Author advises studying spoiled castings according to type and weight to facilitate elimination of various causes. It is stated that large gates decrease defects but impair foundry economy due to higher share of scrap. In all trained labor, efficient machinery and auxiliary devices, proper selection of material guarantee low share of spoiled castings and good steel quality. GN (3)

The Action of Coal Dust as a Facing Material. Ben Hird. *Transactions American Foundrymen's Association*, Vol. 41, 1933, pages 1-19. Coal dust for facing material should contain not less than 28% volatile matter. When used correctly in molding sands, it improves the surfaces of castings and aids their cleaning. It creates a green bond which is developed by milling and which appears to be due to carbon deposited on the sand grains and a tarry substance which distills from the coal. CHL (3)

Influence of Addition of Powdered Coal Upon the Cohesion of Foundry Sands (L'Influenza della Aggiunte di Polvere di Carbone sulla Coesione della Terra di Formature) Ben Hird. *L'Industria Meccanica*, Vol. 15, June 1933, pages 478-480. See "Black Sand," *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 329. Ha (3)

Molding of a Guide Ring (Herstellung eines Leitringes nach Schablone in Sandform) H. Eckart. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Oct. 29, 1933, pages 450-452. Author shows how to sweep mold economically in sand guide ring. GN (3)

Hints for Core Makers (Wichtiges für die Kernmacherei) Hans Eckart. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Sept. 17, 1933, pages 382-384. Discusses errors frequently made in core making. GN (3)

Relation Between Casting Defects and Molding Sand Properties. H. W. Dietert. *Transactions American Foundrymen's Association, Proceedings Section*, Vol. 4, Aug. 1933, pages 31-34. Relations of casting defects to mold hardness and to the permeability, green strength, moisture content and the dry strength are briefly discussed and tabulated. CHL (3)

Grain Structure Control Insures Mold Permeability Control. Harry W. Dietert & Frank Valtier. *American Foundrymen's Association*, Vol. 41, 1933, pages 175-192. The shape of grains of a molding sand has a decided influence on its permeability and strength. Permeability of a rounded-grain sand is greater than that of an angular-grain sand. Rounded-grain sands produce a stronger core than angular-grain sands when the same amount of oil is used. The permeability power of fine material is large and is sufficient to control the permeability of a sand entirely as long as 30% or more of fine material is present. CHL (3)

Influence of Piercing on Gas Permeability of Dense Molding Sands (Ueber den Einfluss des Luftstechens auf die Gasdurchlässigkeit verdichteter Formsande) W. Claus & H. Behrendt. *Die Giesserei*, Vol. 20, Apr. 14, 1933, pages 157-158. Tests were made to determine the permeability of a densely tamped column of various types of molding sands with and without holes pierced in them for letting the gases escape. With holes the permeability of a very dense sand becomes even greater than for a sand of good permeability. But the tests have also shown that the question of permeability is not so important as the rigidity of the molded sand; this influences foundry operations much more. Ha (3)

Making Pattern for the Pieces to form the Spirals of Elevators with Archimedean Screw (La Fabrication d'un Modèle pour Pièces à former les Spires des Elévateurs à Vis d'Archimède) M. Constant. *Revue de Fonderie Moderne*, Vol. 2, Jan. 10, 1933, pages 1-4. Design and manufacture of pattern is described in detail. Ha (3)

Evolution in the Foundry. Snap Molding (Evolution de la Fonderie. Le Moulage par Mottes) M. Constant. *Revue de Fonderie Moderne*, Vol. 27, Feb. 10, 1933, pages 37-42. Examples of molding complicated parts, especially propellers, are illustrated in their different stages. Ha (3)

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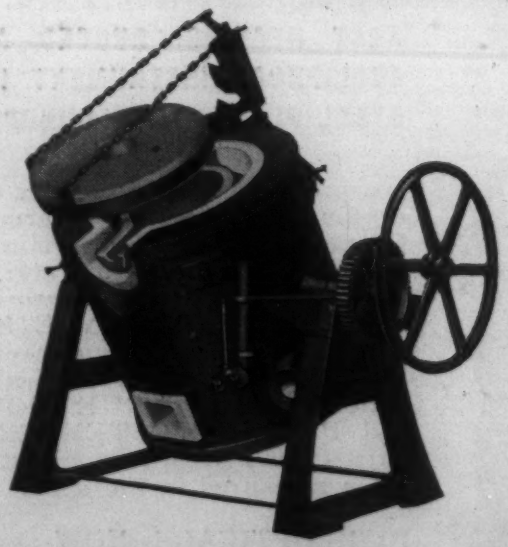

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Non-Ferrous (3a)

G. L. CRAIG, SECTION EDITOR

Saving Babbitt by Covering Melting Pot. JAMES J. BAULE. *Machinery*, N. Y., Vol. 39, Mar. 1933, page 480. Illustrates and gives dimensions of an asbestos board cover to prevent loss of babbitt metal through oxidation. Tests show a considerable saving. RHPp (3a)

Prevent Losses with Proper Gates and Risers. PAT DWYER. *Foundry*, Vol. 61, Jan. 1933, pages 38, 40-41; Feb. 1933, pages 41-42, 44; Mar. 1933, pages 38, 40, 42; Apr. 1933, pages 32, 34, 36; May 1933, pages 36-38; June 1933, pages 62, 64, 66. *37th installment.* Cracks in trolley wheel castings may be due to faulty design, defective metal or style of gate. Most castings are molded two or four in a flask and are gated from central sprue in rim. Under special conditions alternative methods are advisable, including top and bottom gating on hub, also a method whereby the wheels are molded vertically and poured in that position.

2 *38th installment.* Statuary and other bronze castings require different gates from those employed in other branches of foundry industry. Wax sections of varying diameters are rammed up in mold. When mold is dried the wax sections melt leaving passages for distribution of metal to all parts of mold. All passages lead to a common sprue in reservoir in which all the metal is poured. Recommends small wedge gates connected to generous size runners for use on medium size and large tablet castings. *39th installment.* For Cu castings, size and position of feeders, particularly on heavy castings and castings of unequal section is essential. Feeders should be filled with hot metal until the metal has set in an adjoining part of casting. Cu castings shrink from various causes. Familiarity with process and proper equipment is important in production of perfect Cu castings. *40th installment.*

3 Metal remaining liquid in feeding reservoir depends on form, volume and temperature. Molten Cu should be poured rapidly and at fairly high temperature. Large feeding risers are required over heavy sections and it is advisable to fill risers with fresh, hot metal, rather than depend on comparatively cool metal. Cracks in castings may be traced to metal instead of molding and gating features. Either the crucible, the open flame or electric furnace are preferable for melting Cu. Cupola may be used in emergency provided precautions are observed to prevent contamination and oxidation. Charcoal between charges and low blast are recommended. *41st installment.* Gates and risers for Al castings, particular attention is directed to the importance of pyrometric control of the temperature of molten metal and of pouring it at lowest temperature consistent with ability of metal to fill all parts of mold satisfactorily. Metal may be held in furnace for long periods without deterioration. If metal is poured at too high a temperature, resulting casting will be

4 a waster. *42nd installment.* Most important feature in molding an Al casting is to provide a gate that will admit the metal with a minimum amount of disturbance and friction and one which later will compensate for shrinkage of metal. Undue agitation of metal tends to break the film of oxide which forms on surface and produces a drossy substance which later either mars the surface or lodges at some point in body of casting, constituting a defective area and impairs value of casting. Large flat castings usually are gated on opposite sides and metal is poured from two or more ladles. Deep molds are gated as close as possible to bottom so the metal may rise slowly and quietly. One of the main principles in pouring Al or any other metal is to keep the sprue full. VSPp (3a)

5 **Deoxidation of Brasses (La Désoxydation des Laitons)** W. BRONIEWSKI & LEWANDOWSKI. *Revue Fonderie Moderne*, Vol. 27, June 25, 1933, pages 175-182. Brasses with from 33-40% Zn were investigated with respect to mechanical properties of alloys which were subject to oxidation during melting and those which were not oxidized; the latter were melted in a graphite crucible and deoxidized by Al, B, Be, Ca, Mn, Mg, P, Si, Ti, V, 2 Al-Si alloys and one Al-Ca-Si alloy, all in an amount of 0.3%. Hardness, tensile strength, reduction, elongation, elasticity and energy for fracture were measured and all figures are tabulated in full. The best results were obtained with brass of 33% Zn not oxidized in melting and deoxidized with an Al alloy of 87% Al, 13% Si. A pronounced

6 harmful effect is produced by Mg, Mn and especially P. Brasses with 40% Zn gave best results when deoxidized with alloys containing Si, especially 50% Al, 50% Si. In general, the best brass is obtained when oxidation is prevented by melting the constituent metals in a strongly reducing atmosphere containing C. The effect of deoxidizers on brasses which have been oxidized in melting is always less favorable, the best results can in this case be obtained with Al-Si alloys. Hap (3a)

Chill-casting Silumin (La colata in conchiglia del Silumin) J. DORNAUF. *Alluminio*, Vol. 2, May-June 1933, pages 139-153. A review of the practice in chill-casting Silumin, as well as beta- and gamma-Silumin. Microphotographs of articles made by this method are shown. AWC (3a)

7 **Gold Castings.** H. E. HANSON & JOHN SCHOLTEN. *Dental Cosmos*, Vol. 75, Oct. 1933, pages 965-973. According to Hanson and Scholten some authorities assert that 85% of all cast gold inlays exhibit faults. The authors outline in great detail the procedure to be followed in securing cast gold inlays which fit the cavities satisfactorily. The data published by the Bureau of Standards are used in calculating various ways and means of compensating for the approximate 1.25% shrinkage of the cast gold. The major compensation suggested is by casting into an expanded mold at about 1300° F., while minor compensation can be effected by investing the wax pattern at about 98° F. and by using an investment which expands on setting. OEH (3a)

8 **Status of Pressure Die Casting (Stand und Erfolge des Pressgussverfahrens)** W. BRUNNCKOW. *Zeitschrift für Metallkunde*, Vol. 25, Aug. 1933, pages 190-194. A review: methods, mechanical properties, and structure of die castings, limitations, and economics. RFM (3a)

Influence of Manganese, Lead, Iron and Antimony on the technical Electrolysis of Zinc (Untersuchungen über den Einfluss von Mangan, Blei, Eisen und Antimon auf die technische Zinkelektrolyse) HANSJOACHIM VON HIPPEL. Robert Noske, Borna-Leipzig, 1933. Paper 5¾x8¼ inches, 57 pages. Doctor's Thesis, Technische Hochschule Aachen. The harmful effect of permanganate, antimony and ferric sulphate is discussed. Curves for current efficiency at various current densities, temperatures and concentrations of impurities are shown and photographs of many

9 of the deposits are included. H. W. Gillett (3a)-B-

Some Brass Foundry Problems. F. DUNLEAVY. *Foundry Trade Journal*, Vol. 48, Mar. 30, 1933, pages 221-222, 232. Problems discussed concern manufacture of large and small liners, burning-on jobs, types of bearings, and special details involved in use of Al alloys. OWE (3a)

Notes on Foundry Cores (Quelques Remarques au sujet des Noyaux de Fonderie) M. GUEDRAS. *Revue de Fonderie Moderne*, Vol. 26, Sept. 10, 1932, pages 286-287. Attention is called to the importance of the proper condition of the sand for making and baking the cores. The permeability and the contractibility are the principal properties of the binder used in the sand. Ha (3a)

10 **Pattern Plates, Gypsum Frames, Patterns and Core Boxes of Aluminum (Modellplatten, Gipsrahmen, Modelle und Kernkasten aus Aluminium)** HUGO HOLLWEG. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, June 11, 1933, pages 249-251. Numerous examples are discussed showing advantages of light metals instead of iron for foundry implements. Higher first cost is more than balanced by inherent advantages of light metal. GN (3a)

The Mechanism of Inverse Segregation, Alloy Group 3—Tin Bronzes, 89:11 Type. OWEN W. ELLIS. *Metal Industry*, London, Vol. 43, Sept. 1, 1933, pages 194-196; Sept. 8, 1933, pages 223-226; Oct. 6, 1933, pages 353-354. Production of cavities in an ingot is considered as a regular sequence of events in which the order and the manner in which the solid constituents separate out from the liquid, together with contraction on solidification, are of greater importance than the movements of gas bubbles. Porosity distribution appears to be the result of 2 distinct processes, one of which causes the metal to become more porous as solidification goes on, while the other produces a sound cone at the center of the bottom of the ingot. Greater rate of cooling at the outside, segregation of dissolved gas to the center and the fall of hydrostatic pressure as solidification proceeds, are instrumental in bringing about porosity. Contraction on solidification produces inverse segregation to the extent that inter-dendritic feeding is possible; if this is hindered, gas evolution and inter-dendritic porosity is promoted. If castings suffer from large cavities or spongy localized patches the remedy is either better feeding or the choice of an alloy with a longer freezing range which will distribute the porosity. If, on the contrary, extensive porosity is the trouble producing permeability of the casting under pressure, an alloy with a shorter range of freezing, with more rapid cooling and less gas content is likely to be better. Hap (3a)

Further Observations on the Distribution of Porosity in Aluminium and Copper Ingots, with Some Notes on Inverse Segregation. N. P. ALLEN. *Journal Institute of Metals*, Vol. 52, 1933, pages 193-208, discussion, 209-220; *Metal Industry*, London, Vol. 43, Sept. 22, 1933, pages 291-294; discussion, Oct. 20, 1933, pages 395-397. Three Cu ingots and 4 Al-alloy ingots were cast. Big-end-up and little-end-up ingots were made. One Cu ingot was very porous. The 2 others were normal tough-pitch Cu. Of the Al-alloy ingots, 2 contained 10.3% Si and 2 6.7% Cu. All ingots were sectioned vertically and densities of small samples from the new face determined. Lines representing equal densities in the sectioned plane were plotted and the significance of the results discussed in connection with these. The Cu ingots had a high-density shell and a high-density cone arising from the bottom, the cone being more pronounced in the big-end-up ingots. The Al-alloy ingots were similar except that the cone was less pronounced or absent. The mechanism of solidification is discussed in light of these results as well as those with earlier experiments with Cu. Analyses indicated inverse segregation in the Al-alloy ingots. This type of segregation is attributed to shrinkage of the first metal to solidify followed by a filling up of the cavities formed by the still-liquid material, which contains an excess of Si or Cu. Calculations based on estimates of contraction and composition of the eutectics prove that such a mechanism can account for the segregation observed. 11 references. Ha + JLGp (3a)

Silver Copper Alloys Containing Phosphorus. (Phosphorhaltige Silber-Kupferlegierungen) H. MOSER, E. RAUB & K. W. FRÖHLICH. *Metallwirtschaft*, Vol. 12, Sept. 1, 1933, pages 497-501. When commercial O-free Cu is used for making Ag-Cu alloys .007% P is enough to prevent oxidation during casting and produce metal which can be bright annealed. If Cu containing oxides is used, a higher percentage of P is necessary, enough that some remains in the alloy, and several minutes must be allowed for the P to react with the alloy before pouring. To determine whether sufficient P to deoxidize had been used the hydrogen embrittlement test was used, making an Erichsen test after annealing in H. Small quantities of oxides cannot be detected microscopically. From samples which were intentionally oxidized and then deoxidized with P it was found that $CuPO_3$ is formed. This reaction is not reversible. The system Ag-Cu-Cu_3P was investigated. An eutectic containing 17.9% Ag, 30.4% Cu, and 51.7% Cu_3P melts at 646°C. This is equivalent to 7.2% P. The effect of P additions on the mechanical properties of the 50% and 83.5% Ag alloys was determined on annealed sheets and wires. The effect on the tensile properties of the 83.5% alloy is very irregular due to segregation of the P. In the 50% alloy as low as .1% P increases the elongation considerably, which reaches a maximum at about 1%, then drops off slightly. The tensile strength increases with more than 1% P. By P additions lower annealing temperatures can be used for annealing as it increases the grain growth of cold worked alloys. The Brinell hardness of both alloys is reduced by small amounts of P, especially after the higher annealing temperatures. With higher P the hardness increases again. The Erichsen ductility is increased by P up to about .5% and remains constant with higher amounts. The results are more consistent than with P free alloys. The Brinell hardness of the quenched and aged alloys is not affected by P additions. Corrosion tests in 5% HNO_3 gave irregular results, most of the P containing samples corroding faster than the P free sample. The resistance to 5% acetic acid was increased by P in proportion to the amount added. CEMp (3a)

Recent Processes for the Recovery of Secondary White Metals and Bearing Metals. (Neuere Wege in der Metallurgie der Lager- und Weissmetalle.) F. VOGEL. Wilhelm Knapp Verlag, Halle (Saale), 1933. Paper, 6¼x9¼ inches, 97 pages. Price 7.50 RM. The tin base and lead base bearing metals of commerce, the various type metals, the lead, tin and zinc base die casting alloys and the lead tin solders, are listed by composition. Lead and tin ashes, drosses, etc. are rated on the basis of the metal content and of the impurities present.

The processes for purification of mixed white metals, containing chiefly Pb, Sb, Sn, Cu, are described. Rough separation, made by liquation processes, is discussed from the equilibrium diagram point of view. Methods for elimination of Cu by S, and of various minor impurities by oxidation, are briefly described.

Special attention is given to the Harris process, and to special modifications of it, and also to an electrolytic process, using a fluosilicic acid electrolyte of such concentration and with such Pb and Sn content that a cathode deposit of 50% Sn, 50% Pb, suitable for solder, and an anode slime rich in Sb and Cu may be obtained. The caustic solution from the Harris process and the spent silico-fluoride electrolyte are used together in a "ring process" to regenerate the solutions.

In the combined processes the lead-rich raw material is worked in cupolas or reverberatories, freed from Cu by the S method and sent through the Harris process to produce hard lead and electrolytic Sn. The tin-rich material after some fire-refining is cast into anodes and most of its tin obtained by electrolysis as 50% Sn, 50% Pb alloy. The anode slimes are again cast into anodes and the Sn electrolytically dissolved into an electrolyte that goes back to the bath for the deposition of the 50% Sn, 50% Pb alloy. The slimes from this are freed from Cu and the Sb refined.

Anyone working in the white metal refining business will find the booklet of distinct interest. It concludes with a list of 130 German patents on white metal alloys and refining processes. H. W. Gillett (3a)-B-

Position of Gold in Electromotive Series in Electrolysis of Molten Metal Alloys. (Über die Stellung des Goldes in der Spannungsreihe der Elektrolyse geschmolzener Metallegierungen.) L. LÄMMERMAYR & R. KREMANN. *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse*, Abt. II b, Vol. 141, No. 8, July 8, 1932, pages 723-728. Experimental difficulties due to the high m.p. of the alloys, deterioration of the Fe electrodes, and volatilization losses are pointed out. The actual determinations involved alloys of Au with Bi, Sb, Pb and Al. In these alloys Au migrated to the cathode. With reference to the formerly determined electromotive series anode ← He, Ne, Ar, Bi, Sb, Hg, Pb, Sn, Zn, Cd, Cu, Ag, Al, Na, K → cathode, Au must be placed at the right side of Pb. Since no migration of Au could be found in liquid Al, Au should be placed near Ag, probably between Ag and Al. A definite proof on Ag-Au and Au-Cu alloys respectively failed. Metallographic evidence of the Au migration in Au-Bi alloys and the accumulation of Au at the cathode is presented. WH (3a)

The Solubility of Oxygen in Gold and in Certain Silver-Gold Alloys. F. T. TOOLE & F. M. G. JOHNSON. *Journal of Physical Chemistry*, Vol. 37, Mar. 1933, pages 331-346. The solubility of O in Au has been measured over a wide temperature range at various pressures, and has been found to be of the order of 0.010 volume per volume of metal at the highest temperature (900° C.) and pressure (70 cm. of Hg) employed. The solubility of O in 3 Ag-Au alloys containing 5, 10 and 20% Au has been measured at temperatures between 850° and 200° C., and under pressures of from 5-80 cm. Above a certain temperature the solubility is proportional to the square root of the pressure and is related to the temperature by the equation $1/Q = K_1 (A - t)$, wherein Q = solubility, t = temperature in °C. and A = m.p. of the alloy. The solubility is a function of the concentration which, for each temperature, can be expressed by the equation $1/Q = K_2 (C + 5.7)$, wherein C = percentage concentration of Au in the alloy. Below this "critical" temperature the apparent solubility is related to the pressure by the equation $Q = a P^k$, in which k diminishes with decreasing temperature. The relation between solubility and temperature, and that between solubility and concentration of Au, are complicated by the appearance of minima in the curves. An explanation of the solubility phenomena at temperatures below the so-called "critical" temperature has been advanced which depends on the assumption of surface effects. The effect of surface first becomes apparent, as the temperature is decreased, at the "critical" temperature. Nitrogen is insoluble in Au and in Ag-Au alloys of the composition investigated. 8 references. EF (3a)

Protection and Refining Slags for the Melting of Brass. (Schutz- und Raffinationsschlacken für die Herstellung von Messinglegierungen.) E. RICHARDT. *Die Metallbörse*, Vol. 22, Sept. 10, 1932, pages 1166-1167; Sept. 17, 1932, pages 1198-1199. The slags employed in brass melting are subdivided into 3 groups: Borax and boric acid slags should be kept quite fluid during the melting operation and rendered viscous and easily removable by sand or clay powder shortly before casting. Richardt critically discusses the statements of Genders and Haughton on the occurrence of ZnO inclusions due to the use of some fluxes (Paper before the Faraday Society 1924). Furnaces with tapping devices near the bottom are preferable. Borax and boric acid slags act directly upon Zn, absorb SiO_2, Al_2O_3, CaO, etc., and reduce the Zn losses due to volatilization. One part boric acid + 3 parts Na_2CO_3 are widely used. The desulphurizing effect of calcined soda is not complete. For cheap brass melts, sand-soda mixtures or glass are employed. Both strongly dissolve oxides, silicates (and Al). Mixtures of Na_2/K_2CO_3 corrode the furnace lining but display a marked dissolving ability. Sn bearing brass is advantageously covered by Na_2CO_3 and alloys rich in Pb are protected by talcum and quartz powder. In European foundries rock or sea salt is greatly favored although less effective than borax or boric acid. But NaCl slags are satisfactory for brasses high in Cu or with higher Sn, Bi, and Sb concentrations. Gypsum is added to NaCl if large quantities of scrap metal are used. EF (3a)

Copper Product Perfected. B. H. STROM. *Engineering & Mining Journal*, Vol. 134, July 1933, pages 281-282. At the Raritan Copper Works at Perth Amboy, N. J., sound Cu sheets are produced by electrolysis. The cell is described and illustrated. WHB (3a)

Electrical Measurement of Cyanide Solution Activity. W. E. JOHN & E. BEYERS. *Journal Chemical, Metallurgical & Mining Society of South Africa*, Vol. 33, Feb. 1933, pages 246-251. Discussion. See *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 288. AHE (3a)

Preparation and Electrolysis of Aluminum Sulphide. (Herstellung und Elektrolyse von Schwefelaluminium.) PAUL RÖNTGEN & HEINZ BORCHERS. *Metallwirtschaft*, Vol. 12, July 28, 1933, pages 431-434. Aluminum sulphide of the composition AlS was prepared by melting Al with FeS in crucibles without the use of flux. The recovery of AlS is very high. Impure Al containing about 10% Fe and 11% Si was converted into pure AlS containing only .21% Si and .01% Fe by treatment with FeS. The impurities were lowered further by the addition of NaCl during melting. Instead of FeS, ZnS, PbS, or CuS can be used. For the conversion of AlS into metallic Al by electrolysis it appears best to use a mixture of 60% AlS and 40% NaCl, which has good fluidity at 700° C. Preliminary experiments disclose that the electrolysis of AlS-NaCl should be cheaper than that of Al_2O_3-cryolite because the decomposition voltage of AlS is 1 volt lower, the current efficiency is 25% higher, the attack on the carbon anodes is less, and the operating temperature is lower. Further laboratory and commercial tests are to be made. 5 references. CEM (3a)

Experiments on the Electrolysis of Molten Binary Aluminum Alloys and the Solubility of Iron in Molten Aluminum at Different Temperatures. (Versuche über die Elektrolyse von geschmolzenen binären Aluminiumlegierungen und der Grad der Lösungsfähigkeit des Eisens in geschmolzenem Aluminium bei verschiedenen Temperaturen.) R. KREMANN, E. I. SCHWARZ & S. LEBLANC. *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse*, Abt. II b (Chemie) Vol. 141, No. 9/10, Oct. 20, 1932, pages 809-822. Preliminary tests on the electrolysis of a Cu-Al alloy at 3-5 amp./mm.² in refractory trays provided with soft wrought Fe electrodes disclosed a cathodic accumulation of Al, while Cu concentrated at the anode. Replacing the Fe electrodes by Krupp's V2A did not eliminate the disturbance due to the dissolution of Fe at the required working temperature of 1100° C. so that investigations along this line were abandoned as hopeless. A lower melting Al-Sn alloy with about 85% Sn electrolyzed at 660° C. was not accompanied by any deterioration of the Fe electrode which however started at about 800° C. Further tests were made on Al-Sn alloys electrolyzed in capillaries instead of troughs. These experiments yielded the better results the smaller the diameter of the capillaries. No pronounced dissolving of Fe was noticed even at 760° C. Tests on the solubility of Fe electrodes in molten Al proved the absence of this effect at 660° C. Chemical dissolution takes place at higher temperatures with no current passing. With the current on, principally an anodic dissolving of Fe occurs. Stainless steel electrodes (V2A) checked this deficiency but slightly. All experimental results are tabulated and shown in diagrams. WH (3a)

Experiments on Electrolysis of Iron-bearing Aluminum-Tin Alloys as a Model for Electrolytic Elimination of Iron from Molten Aluminum. (Versuche über die Elektrolyse eisenhaltiger Aluminium-Zinn-Legierungen als Modell der elektrolytischen Reinigung von geschmolzenem Aluminium von Eisen.) R. KREMANN & L. LÄMMERMAYR. *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse*, Abt. II b, (Chemie) Vol. 141, No. 9/10, Oct. 20, 1932, pages 823-828. Al-Sn alloys with about 1% Fe were submitted to electrolysis at 6 amp./mm.² for 4 hrs. at 660° C. in porcelain capillaries provided with Fe electrodes. With reference to Sn, the efficiency of the electrolysis was found to depend on the Al content of the melt, a maximum being established at 25% Al. This general trend was also noted with respect to the Fe "output." The experimenters conclude that no migration of Fe would take place in "pure" Al at the current densities employed so that a refining of Al through the agency of an electrolysis in the molten state is not feasible with reference to Fe. WH (3a)

Prevent Losses with Proper Gates and Risers. PAT DWYER. *Foundry*, Vol. 60, Jan. 15, 1932, pages 31-33, 45. Twenty-fifth of a series of articles. Considers gating problems of the brass foundry. Under certain conditions permanent molds may be used in brass foundry as a substitute for sand molds. Brass and bronze should be poured at higher temperature into the permanent molds than into sand molds. Larger gates are required. Large molds are advocated so heat from casting may be absorbed without raising the temperature of the mass above 850° F. VSP (3a)

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Ferrous (3b)

C. H. HERTY, SECTION EDITOR

1 **Introduction to the Physical Chemistry of the Processes for Making Iron and Steel. Vol. 1. The Chemical-metallurgical Reactions and Their Laws (Einführung in die physikalische Chemie der Eisenhüttenprozesse. Vol. 1. Die chemisch-metallurgischen Reaktionen und ihre Gesetze)** HERMANN SCHENCK. Julius Springer Verlag, Berlin, 1932. Cloth, 6¾x10 inches, 306 pages. Price 28.50 RM. This is the first volume of a two-volume essay; it describes in considerable detail the physico-chemical laws and data of importance to the processes for the manufacture of iron and steel. The second volume will deal with practical problems, such as porosity of ore, fluidity of slags, etc., involved in the production of steel, and the application of physical chemistry to the elucidation of practical problems.

2 This volume "is a result of the constant application of physico-chemical methods of thought to the explanation of questions which arise in the process metallurgy of iron and steel"—as conceived and accomplished by one of Germany's most prominent workers in this field. One hundred and fourteen pages are devoted to the "general part," in which the elementary concepts of equilibrium and of phase are first introduced and discussed in relation to homogeneous and heterogeneous systems, followed by chapters on the law of mass action and the phase rule, on the laws pertaining to equilibrium at constant temperature, on thermodynamics (very fully treated), and finally on chemical kinetics. In introducing these orthodox physico-chemical subjects the author has followed the scheme of choosing his examples entirely from the field of metallurgical reactions, a scheme which renders the subject matter more readily understood for his audience than the more general treatment in the ordinary treatises of physical chemistry. In comparison with other texts on this subject, this section is very complete and detailed, fortified by illustrative

3 examples drawn from the metallurgical field; occasionally these examples are discussed quite exhaustively.

The American chemist will doubtless prefer a more modern treatment of thermodynamics than that given here, especially with respect to free energy and the third law (which should be treated more fully); the use of the Nernst nomenclature, rather than the more elegant Lewis, will not rest easily upon American reading eyes. Except for these rather local opinions, no adverse criticisms of any importance can be made. The application of physico-chemical reasoning is experienced and sophisticated, with a clear conception of the limitations involved in some applications (such as the application of the laws of ideal solutions) and of the validity of approximation methods.

4 The "special part" of the book (177 pages) is one of its most attractive features, for here we find summarized in a systematic and critical way the best data available at the time of writing on the systems and equilibria in which iron is one component, on related gas equilibria, and on systems of importance in the study of slag behavior. Starting with the system Fe, the reader is taken through the systems Fe-C, Fe-O, C-O, Fe-C-O, H-Fe, H-C, H-C-O, H-Fe-C, H-Fe-O, H-Fe-C-O, N-Fe, etc., etc.; in all—including the systems involved in refining processes, deoxidation processes, and slag reactions—some one hundred and fifteen systems. In each case the treatment is excellent. No other treatise is so complete nor so admirably presented in this respect; the data assembled and critically inspected are

5 of immediate and practical value to anyone engaged in the manufacture of iron and steel, or in its treatment, and, needless to say, to anyone engaged in research. Such is the activity in this field that many important papers have appeared since the writing of this volume, for example on the atom heat of iron, on the FeO + Mn reaction, on the Fe-O system, on equilibria in deoxidation processes, etc. etc.

This book constitutes the most serious attempt at organizing information and theory concerning the chemical reactions involved in the manufacture of iron and steel, and in quality is far beyond its predecessors. Much of the success of the effort—so far as practical problems are concerned—will depend upon the manner of presentation in the second volume, soon to appear, which many workers will eagerly await. This field is one of continually increasing interest and in not many years will grow into a major research field. Well-written texts in an active research

6 field are of great value, especially in the metallurgical field where texts, handbooks, and treatises in many important subjects are so badly needed; this book is a welcome addition to metallurgical literature. R. F. Mehl (3b)-B-

Gating of Heavy Malleable Cast Iron Parts (Ueber das Anschneiden von schweren Tempergussstücken) WILH. SCHNEIDER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, July 9, 1933, pages 281-282. The author discusses the difficulties that were encountered in casting the chain guide rolls of army tanks. Malleable parts that are prone to cracking upon cooling or subsequent malleableizing are slowly cooled in a pre-malleableizing furnace immediately after casting. However, in the absence of a furnace, the above-mentioned failure which first caused extensive trouble was avoided by a particular method of gating. GN (3b)

7 **Iron for Pressure Castings.** H. H. JUDSON. *Foundry*, Vol. 60, Nov. 1932, pages 24-25, 54, 56. See "High-Test Iron for Pressure Castings," *Metals & Alloys*, Vol. 4, May 1933, page MA 134. VSP (3b)

Casting Printing Machine Frames. J. H. LIST. *Mechanical World & Engineering Record*, Vol. 93, July 7, 1933, pages 642-643. Methods of molding and casting printing machine frames are described. Kz (3b)

Ensuring Uniformity in Pipes During Casting. F. H. MOREHEAD. *Mechanical World & Engineering Record*, Vol. 91, May 20, 1932, pages 485-486. All cores tend to rise in the mold, due to their buoyancy in liquid metal, and on a slender core the displacement may be sufficient to cause uneven wall thickness. By giving the core an initial curvature, subsequent straightness can be assured, and

8 it is then possible to cast successfully thin walled pipes. Kz (3b)

Oxygen in Cast Iron (L'Oxygène dans les Fontes) J. COURNOT, A. LE-THOMAS & L. HALM. *Bulletin de l'Association Technique de Fonderie*, Vol. 16, Sept. 1932 (supplement), pages 24-35. Paper presented at World Foundry Congress, Paris, Sept. 1932. Review of work on effect of O in Fe and steel. Various methods for O and oxide determinations. Two analyses are necessary: (1) total O content, (2) oxide content. 32 references. WHS (3b)

Oxygen in Steel. S. L. LEVIN. *Domez*, No. 4, 1933, pages 36-46 (In Russian). A compilation from the published data. (3b)

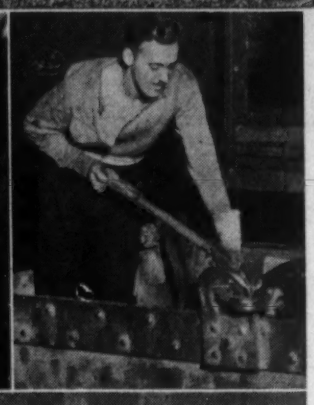
Methods of Determining Gases in Steel Studied. J. G. THOMPSON. *Iron Age*, Vol. 129, Mar. 10, 1932, page 617. Abstract of paper "Determination of

9 Oxygen, Nitrogen and Hydrogen in Steel," presented at annual meeting of the American Institute of Mining and Metallurgical Engineers. Discusses the different methods proposed which have been studied by the U. S. Bureau of Standards. See *Metals & Alloys*, Vol. 3, Sept. 1932, page MA 281. VSP (3b)

Molding of Double-Armed Pulleys on Molding Machines (Formen von doppelarmigen Riemenscheiben auf Formmaschine) ERNST EITER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, June 11, 1933, pages 238-241. Discusses at length molding of double- or triple- armed pulleys on special telescope pulley molding machines. Equipment and operation of such machines are described. Their advantages are pointed out. The costs for patterns, sweeps and flasks are saved,

10 production as compared with manual molding is increased and all pulleys can be cast in green sand. GN (3b)

Drying Oven Truck (Der Trockenofenwagen) K. HÖLZLE. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, June 4, 1933, page 216. Description of the construction of drying oven trucks in general and of a new type in which the car wheels are replaced by steel balls. GN (3b)



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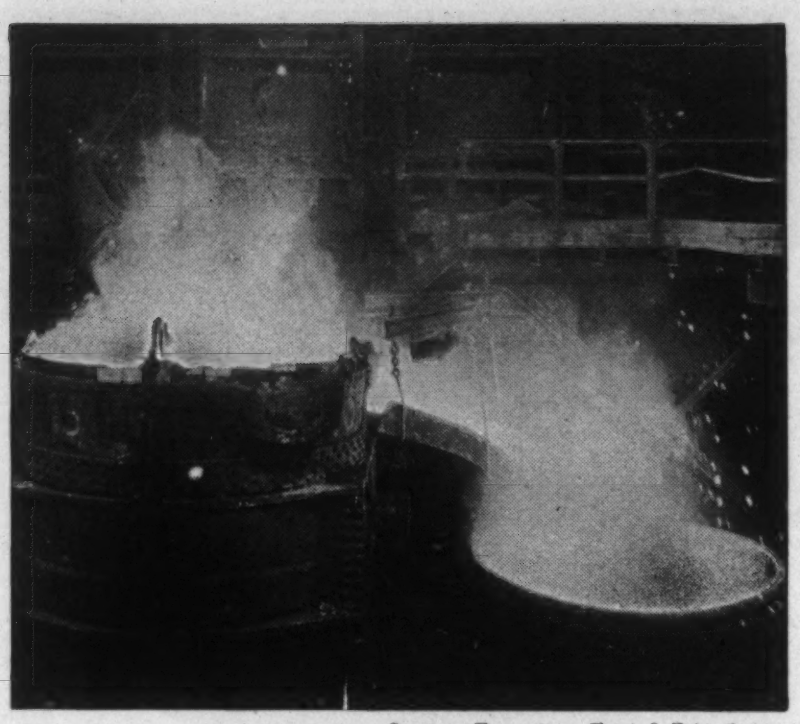

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Equilibrium in the Oxidation of Liquid Iron by Steam and the Free Energy of Ferrous Oxide in Liquid Steel. JOHN CHIPMAN. *Journal American Chemical Society*, Vol. 55, Aug. 1933, pages 3131-3139. Equilibrium in the oxidation of liquid Fe by steam by determining the O_2 content of Fe in equilibrium with controlled mixtures of steam and H_2 is discussed. At constant temperature the O_2 concentration in the Fe is nearly proportional to the mole ratio of steam to H_2. This proportionality leads to the conclusion that the solute is an oxide of Fe containing one atom of O per molecule. Free energy values are given. MEH (3b)

Sand Control In The Steel Foundry. A. V. LEUN. *Iron Age*, Vol. 129, May 19, 1932, pages 1110-1113. Abstract of paper read before the American Foundrymen's Association. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 330. VSP (3b)

Preheating the Cupola Blast. F. K. VIAL. *Foundry*, Vol. 61, May 1933, pages 14-15, 43. Stresses the importance of preheated blast which makes high fuel economy possible along with high melting temperatures and protection of Fe from tendency toward oxidation. Hot blast not only lowers operating expense but permits cupola to do better work. Increase in efficiency of hot blast cupola in transfer of heat to Fe may be as follows: (1) Heat put back into cupola as recovery in sensible state from stock gases and from burning of CO to CO_2 improves combustion in cupola and raises temperature in combustion zone; (2) Completely developed heat introduced with hot blast adds practically nothing to radiation loss, and none of recovered heat is lost from dropping at the end as with unburned coke; and (3) Air used per lb. of coke is practically the same with hot blast as with cold blast. By reducing amount of coke put into cupola proportionally reduces amount of N that must be introduced with corresponding reduction in heat loss with N discharged from cupola. It is evident that recovered heat returned to cupola by hot blast is virtually 100% available for transfer into Fe and therefore much more valuable than heat developed from raw coke. Gives heat disposal diagrams from 1 lb. of coke in 2 cupolas. VSP (3b)

Manufacture of Stainless Iron from Ferrochromium, Scrap, or Ore. A. L. FEILD. *Metal Progress*, Vol. 23, Feb. 1933, pages 13-17. The melting of high Cr steel requires special knowledge and skill due to the oxidation of molten Cr in preference to Fe and the affinity of Cr for C. These difficulties are not involved in Cr steels of 0.50 to 1.75% Cr. C cannot be removed from the bath so low C raw material must be used. All low C stainless is melted, in America, in the basic Heroult electric arc furnace. Stainless scrap is remelted in the induction furnace. In the favorite 6 ton size furnace, low P steel scrap is charged, 200-500 lbs. roll scale or Fe ore added, and the mixture melted. C is lowered to 0.04% or less and the oxidizing slag removed as clean as possible. A finishing slag of lime and fluorspar is then added. Pulverized ferrosilicon, and lime if necessary, is added as needed to maintain a disintegrating $CaSiO_3$ slag. The function of the ferrosilicon is to keep the slag free from Fe and Cr oxides. Si reduces these oxides, returning the metals to the bath. Next the necessary amount of ferrochromium is added in 2 or 3 lots. The electrodes must be kept free of the bath and any pieces of C or graphite removed at once. After the ferro-Cr has been stirred in, tests are taken at 10 to 30 min. intervals for C, Cr, Mn, Si, and Ni if present. Corrective additions are made, the bath brought to temperature, deoxidizers added and the heat is poured. A serious problem is the excessive wear of the refractories due to the high melting points of the materials. Tapping temperature can only be estimated by an experienced operator. Varying amounts of Cr do not appreciably lower the freezing point of Fe. Time of a heat averages 5 hours with power consumption about 650 kw.-hr. per ton of ingots. Direct production of ingots from Cr ore by Wild and from high C ferro-Cr by the author are mentioned. Successful in some respects, the methods are not at present practicable. The factors affecting the present and future price of stainless are discussed. WLC (3b)

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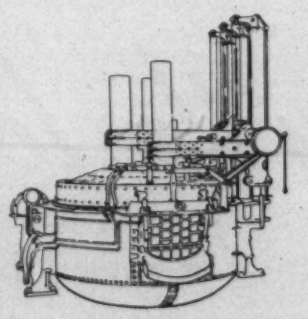

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Influence of Cooling Velocity and Melting Temperature on the Graphitization of Cast Iron. HIROMU TANIMURA. *Memoirs College of Engineering Kyushu Imperial University*, Vol. 6, 1931, pages 115-188. Structure of cast Fe with various amounts of C and Si was investigated by varying cooling velocity and melting temperature. When C content is constant in specimens graphitization takes place as Si content exceeds a critical amount, irrespective of cooling velocity. If Si content is below critical amount, graphitization takes place with difficulty. On other hand, as Si content exceeds critical amount, graphitization cannot be suppressed, even by rapid cooling. Tensile strength of series of specimens with 2.8% and 3.6% C is largest in that containing critical amount of Si and suddenly decreases as Si content exceeds critical composition, this being more marked in 3.6% C series. Effects of melting temperature on graphitization is different, according to cooling velocity. In rapid cooling, graphitization takes place with difficulty, when melted at a high temperature. In slow cooling, graphitization is differently affected according to chemical composition; that is, in specimens with high C and high Si contents, degree of graphitization increases, as melting temperature rises. In specimens with high C and medium Si contents, degree of graphitization is minimum, when melted at temperature range of 1400°-1500° C. In low C alloys, effect of melting temperature is slight. When Si content is less than critical, no graphitization takes place even by slow cooling, if melting temperature is high. Specimen melted at a high temperature is markedly supercooled and fine graphite is formed, resulting in heterogeneous structure, irrespective of cooling velocity. Relation between stability of cementite and melting temperature was also studied. Cementite in specimens melted at a high temperature is more readily graphitized than that in specimens melted at a low temperature. From these facts, mechanism of graphitization in cast Fe, melted at a high temperature was given as follows: fine graphite which is generally believed as eutectic graphite is not that which was formed by eutectic reaction, and is that formed by decomposition of eutectic cementite after solidified as a white pig, while a cast Fe melted at a low temperature solidifies with direct crystallization of graphite. Heterogeneous structure to be readily formed in cast irons melted at a high temperature is caused by segregation of Si caused by supercooling. TM (3b)

Thermal Properties of Ingot Mould Irons. J. G. PEARCE & E. MORGAN. *Foundry Trade Journal*, Vol. 46, May 5, 1932, pages 272-273, 284. An extract from the 4th Report on the Heterogeneity of Steel Ingots, sponsored by the Iron and Steel Institute and other associations in Great Britain. See *Metals & Alloys*, Vol. 4, Feb. 1933, page MA 43. OWE (3b)

Refining, Pouring and Treating Basic-Bessemer Rail Steel Ingots. (Ueber Erzeugung, Vergiessen, und Behandlung von Thomas-Schienenstahlblöcken.) K. EICHEL. *Stahl und Eisen*, Vol. 53, May 18, 1933, pages 521-532. Statistical studies were made of the effect of variables in the refining, pouring, and treatment of basic Bessemer rail steel ingots on defects and rejections of the rolled rails. The lime should contain about 90% CaO; poor lime is as harmful as poor pig iron. The latter should contain 3.5% C; at most 0.5% Si; 1 to 1.2% Mn; 1.8% P; and at most 0.07% S; it should be at about 1200°-1250° C. when poured into the converter. The blow should be as short as possible and at a controlled temperature. Deoxidation with Fe Mn should preferably be in the converter; molten Fe Mn gives better recovery of Mn than solid Fe Mn. Fe Si is added in the ladle and Al may be added in the mold. Mold washes and dimensions are discussed. The teeming temperature should be about 1510° C.; better results were obtained with top pouring than with bottom pouring. Heating in the soaking pits is discussed; 1150° C. (2100° F.) seems to be a favorable rolling temperature. The finished steel has the following composition depending on the strength requirements and the rail section; C 0.35-0.45%; Mn 0.70-1.20%; Si 0.7-0.12% (low Si), 0.20-0.30% (high Si); S 0.08% max.; P 0.05-0.1%. The steels higher in Si appeared to give more surface defects. SE (3b)

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WORKING OF METALS & ALLOYS (4)

RICHARD RIMBACH, SECTION EDITOR

Rolling (4a)

1 **The Influence of Friction in Rolling Steel Strip (Der Einfluss der Reibung beim Walzen von Bandstahl)** W. LUEG & EGON OSENBERG. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung*, Vol. 15, No. 8, 1933, pages 99-105. A certain amount of friction between roll and material to be rolled is required to secure gripping. The influence of this friction on resistance to deformation and energy consumption was determined for C steels and Si alloy steels with dry, lubricated and artifically roughened roll at different temperatures. It was found that an increase of friction always causes an increase of resistance to deformation, of widening and of energy required for rolling. The test results are reproduced in detail. 10 references. Hap (4a)

2 **New Developments in Tube Rolling Methods (Neuere Entwicklung von Rohrwalzverfahren)** F. KOCKS. *Stahl und Eisen*, Vol. 53, July 6, 1933, pages 689-701. The mode of deformation in the usual tapered tube rolling mill is discussed—thus making clear why the rolling of such thin walled tubes had heretofore been unsuccessful. Three new and improved tapered tube rolling methods developed and tested on a practical scale at the tube mills of the Vereinigte Stahlwerke in Düsseldorf are then described. Pilger calibrations resulted in a reduction of tube wall thickness. SEp (4a)

3 **Effect of Concavity of Rolls on Operation.** DAVID T. DAVIES. *Blast Furnace & Steel Plant*, Vol. 21, Sept. 1933, pages 469-470. Chief factors in determining amount of concavity to be turned in the rolls are width of sheet to be rolled; amount and kind of work to be done; and the length of service of the rolls. If the rolls are too full, the end of the pack becomes rounded, the middle of the pack forms "hog backs" or pinchers; and the pack will tend to run toward one end or the other of the rolls. If the fullness is not excessive, it may be corrected by applying steam and turning off the water running on the necks. If the rolls are too concave, the end of the pack will be hollow, and the sides of the pack will be wavy. If this condition is not excessive, it may be corrected by careful heating of the rolls. MSp (4a)

4 **Modern Sheet and Tin Mill Practice.** F. A. BEATTY. *Blast Furnace & Steel Plant*, Vol. 21, Dec. 1933, pages 627-629. Describes a proposed lay-out of equipment in which the material flows continuously in one direction. As an example in manufacturing tin-plate, sheared bars would be heated in continuous pair furnaces and then rolled on 3-high roughing-mills to the proper gage, doubled and trimmed. Considerable space is allowed between these doublers and the continuous pack furnaces, in which the material, called "4s," is heated for further rolling. It is then rolled on 2-high finishing mills, doubled, trimmed and thrown on a return conveyor which brings the doubled pack back to the charging end of the pack furnace. After reheating, the material is rolled to tin gage on the same 2-high finishing mill. This is called rolling "8s." The subsequent operations in making tin-plate would be carried on as heretofore. Predicts that 3-high mills will soon be used for finishing off light-gage sheets and tin-plate. MS (4a)

5 **Breakage of Sheet and Tin Rolls.** W. H. MELANEY. *Blast Furnace & Steel Plant*, Vol. 21, Nov. 1933, pages 577-578, 586. Discusses various theories which have been advanced to account for the breakage of chilled rolls. Author believes that 95% of the breakage of sheet and tin-plate rolls is due to heating the chilled surface of the roll too rapidly. This surface has an expansion twice as great and fast as the center of the body. The rapid expansion of the face of the roll pulls the softer center in two. Author is of the opinion that rolls do not bend perceptibly. Holds as erroneous statement made recently that rolls too full cause pinched sheets. (This probably refers to *Blast Furnace & Steel Plant*, Vol. 21, Sept. 1933, pages 469-470.) MS (4a)

6 **Cause of Rigidity of Electrolytic Zinc Sheets.** A. A. BOCHVAR & A. YA. ULYANOV. *Tzvetnuie Metallui*, May-June 1932, pages 33-36. Experiments indicated that the "rigidity" of rolled electrolytic Zn sheets of any one batch does not depend on the variations in rolling temperatures, and that differences in the rigidity of sheets rolled from Zn procured from different manufacturers depend on the presence of impurities which raise recrystallization temperatures. It was found that 0.02% of Fe raised the recrystallization temperature sufficiently to render the rolled sheets "rigid." Cd was found to have little effect on rigidity, although the hardness was considerably increased. Pb was found to have no effect. BND (4a)

Sheet and Tinplate Rolls. J. SELWYN CASWELL. *Blast Furnace & Steel Plant*, Vol. 21, Feb. 1933, page 120; Mar. 1933, page 172; Apr. 1933, page 224; May 1933, page 276; June 1933, page 332; July 1933, page 384; Aug. 1933, page 436; Sept. 1933, page 496. Parts of a serial abstract of paper read before the South Wales Institute of Engineers. See *Metals & Alloys*, Vol. 2, Jan. 1931, page 11. MS (4a)

7 **American Practice in Cold Rolling Steel Strip.** C. E. DAVIES. *Iron & Steel Industry & British Foundryman*, Vol. 6, Apr. 1933, pages 249-251. General notes on experience gained by author during visit to American cold rolling plants. CHL (4a)

Development of Manipulators in Rolling Mills (Entwicklung der Kantvorrichtungen im Walzwerksbetrieb) J. GASSEN. *Stahl und Eisen*, Vol. 53, Sept. 14, 1933, pages 953-956. Various manipulators in blooming mills and shape mills are illustrated. SE (4a)

Rolling Rails in a Russian Mill (Schienenwalzung auf einem russischen Hüttenwerk) F. BRAUN & H. KETTLER. *Stahl und Eisen*, Vol. 53, Sept. 7, 1933, pages 930-934. Two new roll designs are illustrated which should result in raising production to the required amount. SE (4a)

8 **Stress Distribution and Metal Flow between Rolls (Spannungsverteilung und Werkstoffffluss im Walzspalt)** W. LUEG. *Stahl und Eisen*, Vol. 53, Apr. 6, 1933, pages 346-352. The pressure between the rolls during the rolling of rectangular sections was measured by a piezo-electric method. The pressure was greatest between the middle of the rolls and diminished toward the ends. The effect of friction, cross-section of the work, and amount of reduction on the pressures was studied. Applying tension to the work as in a Steckel mill reduced the maximum pressure in the middle and distributed it more uniformly along the length of the rolls. SE (4a)

9 **New Methods for Study of Seamless Tube Rolling Process (Untersuchungen über den Pilgervorgang. Die Anwendung neuzeitlicher Messverfahren bei Walzwerkuntersuchungen)** F. KOCKS. *Stahl und Eisen*, Vol. 53, May 4, 1933, pages 441-446. Electrical methods for measuring rolling pressures and a torsion dynamometer and stroboscope for the study of the seamless tube rolling process are described. The devices were developed in the laboratory and have not yet demonstrated their practical utility. SE (4a)

Manufacture of Steel Sheets. JAMES BRYDEN. *Blast Furnace & Steel Plant*, Vol. 20, Sept. 1932, pages 721-722, 726; Oct. 1932, pages 774-777, 788; Nov. 1932, pages 841-842, 855; Dec. 1932, pages 896-897, 903. Paper read before the West of Scotland Iron and Steel Institute. See *Metals & Alloys*, Vol. 4, July 1933, page MA 226. MS (4a)

10 **Dynamic Strainmeters and Oscillographs for Studying the Process of Rolling (Dynamische Dehnungsmesser und Oszillographen zur Untersuchung des Walzvorganges)** H. HOFF & T. DAHL. *Stahl und Eisen*, June 8, 1933, pages 593-604. The advantages of dynamic strainmeters and oscillographs for studying the process of rolling are brought out by tests in a blooming mill. There is a lengthy discussion on various topics including the resistance to deformation of strip steel at rolling temperatures between 20° and 700° C., deformation and stress distribution in rolling, effect of temperature on the shape of the bloom. SE (4a)

Forging and Extruding (4b)

Mechanical Properties of Very Large Forgings (Beitrag zur Kenntnis der mechanischen Eigenschaften grösster Schmiedestücke) E. MAURER & H. KORSCHAN. *Stahl und Eisen*, Vol. 53, Mar. 2, 1933, pages 209-215; Mar. 9, 1933, 243-251; Mar. 16, 1933, 271-281. Four 100-ton ingots were cast by mixing in a single mold the melts from 2 furnaces, one a 60-ton acid open-hearth, the other a 60-ton basic open-hearth. One of the ingots was a plain 0.20% C steel; another of 0.25% C, 1.2%Mn; a third of 0.25% C, 1.9% Ni; and the fourth of 0.35% C, 1.3% Cr, 2.5% Ni, 0.5% Mo steel. Details are given in regard to teeming and forging; the rates of preheating the ingots and cooling after forging are illustrated graphically, as are also the annealing, normalizing, and oil quenching treatments. Each ingot, originally about 2100 mm. in diameter, was "step" forged to form blooms 980, 1180, and 1450 mm. in diameter. The tensile and impact properties, in the longitudinal and transverse direction, from the center to the outside of the blooms, after various heat treatments, are shown in curves and tables. The grain size at the center, midway between center and outside, and at the outside of the different blooms after annealing, normalizing, and oil quenching are also shown. In the heavier blooms there was no appreciable difference in grain size as between normalizing and oil quenching; both of these treatments produced fairly fine grained structures. The occurrence of flakes and woody fractures in the Cr-Ni-Mo steel is illustrated and discussed. In the transverse specimens the amount of reduction in forging had little effect on the yield point and tensile strength, but the elongation, reduction of area, and impact resistance were materially lowered with increased reduction in forging. In the longitudinal specimens all of the mechanical properties improved as the amount of reduction in forging increased. In the extended discussion of the paper the subject of flakes in the Cr-Ni-Mo steel was considered and attributed mainly to rapid cooling and to segregation. SEp (4b)

Forging with the Welding Torch (Das Schmieden mit den Schweissbrenner) C. F. KEEL. *Zeitschrift für Schweisstechnik*, Vol. 23, Nov. 1933, pages 284-289. The welding torch is used to heat metal parts for forging. This method has a great advantage over the use of the forge fire in that the welding flame consists of reducing gases that will not oxidize the metal, and will, in fact, reduce oxide films such as the roll scale. Thus the iron is chemically purified under the welding torch. Use of the torch in this way has the further advantages of cheapness and speed. The burner is always ready and the temperature of the flame is high, so that heating is completed in the briefest possible time. A table shows the time required for heating and gas consumption. RRS (4b)

Manufacture of Non-ferrous Seamless Tubes by Piercing and Extrusion Methods. GILBERT EVANS. *Metallurgia*, Vol. 8, Oct. 1933, pages 167-170. Small tubes can be economically extruded but large tubes must be pierced. Several types of extrusion presses are described. JLG (4b)

Practical Plasticity Problems. GEORGE M. EATON. *Mechanical Engineering*, Vol. 55, Sept. 1933, pages 557-560; *Metal Stampings*, Vol. 6, July 1933, page 194. The close relation of problems of plasticity and flow of material is discussed and explained by the behavior of ingot molds and steel ingots. The method to approach these problems by proper analysis from properly made tests is described. The fundamental requirement for creep and plasticity tests are that the test piece must include the whole range of a service piece (i.e. for instance 360° for a tube), the type of stress imposed in the test must coincide with service stress, and tests must be conducted not only on specimens of the "as-shipped" condition but also on pieces taken from material after different times of operation; tests should be of short duration. Close coöperation between metallurgical and mechanical engineer and the laboratory staff is advocated. MS+Ha (4b)

Technique of Heavy Forging. RONALD BENSON. *Iron & Coal Trades Review*, Vol. 127, Dec. 1, 1933, page 834. Laying out of procedure, determination of material needed and size of starting ingot, heating problems, furnace types and fuel consumption is discussed. Ha (4b)

Double Drop-Forging Hammer (Der Doppel-Gesenkhammer) H. BECHÉ. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Oct. 21, 1933, pages 1149-1150. A construction with 2 balanced hammers is described in which all energy is used for the operation so that no loss of energy to the ground or the supports reduces the economy of the operation. Ha (4b)

Wire Rope Sockets Are Drop Forged to Finished Size. T. J. BLACK. *Steel*, Vol. 92, Mar. 27, 1933, page 27. Sockets for anchoring the cables of suspension-bridges are forged so closely to specified dimensions that only machining of eye sections and lead grooves is required. S. A. E. 1040 steel is commonly used and is heat treated to meet A. S. T. M. specifications A-18-30, Class E. MS (4b)

Electric Heat in the Drop-Forging Industry (Elektrowärme in der Gesenkschmiede-Industrie) H. KAESSBERG. *Elektrowärme*, Vol. 3, June 1933, pages 125-128. Electric butt-welding machines for use in forging are described. 2 methods are used: either the stationary method where the 2 ends are brought together, heated and pressed together, or, recently more often by the fusion method, whereby the butt-ends are separated, after having been in contact for a short time, for the fraction of an inch so that an arc over the whole surface is produced which heats the ends very quickly. Impurities are removed by the arc. This method gives 100% of the strength of the material. Welding machines of this type are described for different purposes, in particular they are used for automatic chain making with links up to 18 mm. diameter; 225 links can be made/hr. with 8.7 kwh./100 links while with 2 mm. diameter 2100 links can be made entirely automatically with 0.05 kwh./100 links. Pieces with 30,000 mm.^{2} section can be welded in modern machines. Another field is the electric upsetting machine. Types of Omes and Giacchino are described. It is of particular advantage that little scale is produced and little scrap results, and in upsetting bolts and screws the fiber in the piece has a good shape from the viewpoint of strength. Ha (4b)

Advances in Die Making Result in Better Forging. GEORGE S. BRADY. *Iron Age*, Vol. 131, Apr. 20, 1933, pages 615-616. Outstanding accomplishments in forging since the war have been the introduction of coining and use of alloy steels in dies. Improvements in forging dies and forgings were brought about by experiences gained in making dies for pressure molding and die casting, as well as for drop forging. Alloy steels used for steel forging dies are Ni-Cr, or Ni-Cr with some Mo. They are either oil- or air-hardened. For low production runs the C steel dies (0.60-0.65% C) are still the most economical. Alloy steels tempered to 310 to 360 Brinell give good results without heat treatment. Die shape and size of stock are carefully planned before work on tool is started. VSP (4b)

Generalized Diagram for Forgeability. S. A. MAIN. *Metal Progress*, Vol. 23, Jan. 1933, pages 47-48. A simplified formula from that given by Ellis' article on forgeability in Sept. *Metal Progress*, is explained. A graph on log-log coordinates, where relation between energy of blow and reduction of normal ½ in. sample plots as a straight line, is given. WLC (4b)

Hints on Forging the Stainless Steels. R. W. THOMPSON. *Metal Progress*, Vol. 23, Apr. 1933, pages 25-28. Suggestions for forging various types and sizes of stainless steel are given. Heating operations are especially important because of grain growth at high temperature. The operations are prolonged by the additional number of hammer blows required by stainless. Selection of material, equipment, heating methods, forging defects, die steels, trimming, and cooling, are discussed with suggestions for improved practice. WLC (4b)

Forging Light Metals. C. ZÜBLIN. *Engineering Progress*, Vol. 13, Aug. 1932, pages 174-176. Duralumin may be forged at a maximum temperature of slightly over 500° C. Elektron metal will only stand a much lower temperature. This material may be forged down to a much lower temperature. Duralumin will work down to a temperature of about 450° C. Describes forging apparatus and process used for an aero-engine and its parts. RHP (4b)

Cold Working, including Shearing, Punching, Drawing and Stamping (4c)

1 **New Special Oils for the Working of Aluminum (Neue Spezialöle für die Verarbeitung des Aluminiums)** K. KREKELER. *Werft, Reederei und Hafen*, Vol. 14, Sept. 15, 1933, pages 264-266. Appearance of dark spots on rolled Al foil and billet sheets is ascribed to the incombustible residue of burnt oil. Cylinder oils with a higher flash point did not remedy this trouble, whereas rather viscous oil, carefully refined (for instance with SO_2) did not leave noticeable residues and turned out to be more economical. This oil, however, can be used only down to 2.0-2.5 mm. thickness. Less viscous oil must be applied to come down to 0.005 mm. foil. Mechanical lubrication is recommended and a suitable device for wiping off the oil is shown referring to an Al strip mill. Since a different kind of oil or even fat is being used for the neck, arrangements are indispensable to prevent the lubricant from passing onto the rolls and rolling material. Corrosion of the rolls can be prevented by adding a special protective oil (1%) to the cooling water.

2 During the rolling of Al tubes, the mandrel is liable to attain 500° C. Graphite is advantageously added to the lubrication oil. For drawing, drilling, turning and milling a mixture of 1 part of emulsifying oil and 10 parts of water is best suited. For grinding purposes a ratio of 1:100 should be observed. An apparatus for testing of the oil concentration of water-oil emulsions is described. WH (4c)

Experiments in Wire-drawing. Part III. Annealing of H. C. Copper Wires Drawn to Varying Degrees of Hardness. W. E. ALKINS & W. CARTWRIGHT. *Institute of Metals*, Advance Copy No. 637, Sept. 1933, 19 pages; *Metal Industry*, London, Vol. 43, Sept. 22, 1933, pages 297-298; *Fuels & Furnaces*, Vol. 11, Sept.-Oct. 1933, pages 186-187. All samples were obtained from a single wire bar of Ag-free Cu containing 99.95% Cu, 0.003% Fe, and 0.047% O (by

3 difference). Samples were annealed at different diameters and drawn to 0.104" wire, the final reductions by cold-drawing amounting to as much as 96.7%. Samples of wire from each cold-drawn piece were annealed at different temperatures for the times ½, 1, 2, 6, 12, and 24 hr. Breaking strengths were determined. The many data obtained are given in both tables and curves. It was observed that the greater the amount of reduction by cold-work the lower the temperature is at which softening begins and the more rapid the loss at a constant temperature. The strength of "fully-annealed" wire increased with increased reduction prior to the final anneal. Severely worked wires softened slowly at a temperature as low as 130° C. For ½ hr. annealing periods the softening temperature (steep portion of the temperature-strength curve) was near 200° C. The strength of some wires increased slightly on heating to low temperatures. Ha + JLGp (4c)

4 **Effect of Cold Working on the Izod Notched Bar Impact Value of Monel Metal.** N. B. PILLING. *Proceedings American Society for Testing Materials*, Vol. 32, Part 2, 1932, pages 576-583; *Metal Industry*, London, Vol. 41, Sept. 2, 1932, pages 229-231. Notched bar Izod value of Monel metal is first increased and then decreased by cold working. Maximum occurs at about 10% reduction by cold work, corresponding to a Brinell hardness in the range 155 to 175. Stress relief annealing increases both hardness and impact value. Impact properties of drawn rods are sensibly uniform and do not depend upon relative direction of bending. Impact properties of rolled flats are highly directional and depend upon position of notch with respect to axes of rolling. Impact value is greatest when notch lies parallel to breadth dimension of flat. Correlation between hardness and

5 Izod value is good only when working is followed by a low-temperature anneal. Under these circumstances Izod value is closely related to apparent Brinell hardness of fiber parallel to bottom of notch. VVK (4c)

Problem of Cold-Heading of Bolts. (Das Kaltstauchproblem der Schraubenfertigung.) W. AUMANN. *Zeitschrift für Metallkunde*, Vol. 24, Sept. 1932, pages 200-206. A mathematical treatment of flow-process in cold-heading of bolts is given, including cold-heading stress-strain diagrams for brass, Fe, Ni and duralumin, from which maximum cold-heading can be read. Influence of heading speed is not as yet understood. RFM (4c)

The Wire Drawing Die. KENNETH B. LEWIS. *Wire & Wire Products*, Vol. 8, July 1933, pages 197-200, 219; Aug. 1933, pages 234-239, 243, 251; Sept.

6 1933, pages 266-269; Oct. 1933, pages 331-333. The stresses and strains during drawing operations are studied and explained by the wedge action of the wire pulled through the conical die. The forces exerted and to be overcome are determined on this basis. Formulae are developed and tables given for calculating the forces required for different reductions considering the yield point of the wire. Ha (4c)

Stresses in Wire Drawing. A. C. BLACKALL. *Wire & Wire Products*, Vol. 8, Aug. 1933, pages 232-233. Stresses in wire during drawing were experimentally investigated from which it was concluded that the most important factor in the design of the die is consideration of friction or surface drag. The energy expended after drawing wires was calculated for 2 ways of drawing: (1) in the ordinary way, (2) with considerable tension in the wire at the back of the die; in the

7 latter case, the die loads were much lower and the work against friction was smaller. Cleaning of the wire is important, no scale should be left on it. The harder the material of the die in relation to the hardness of the wire the lower will be the frictional forces. A tungsten carbide die used in the work had a hardness of 1350; the finish (polish) of the die should be as high as possible. For most purposes an angle of 5°-8° seems to be the most satisfactory. Ha (4c)

The Hammering and Shaping of Sheets. G. DUBOIS. *Sheet Metal Industries*, Vol. 7, Aug. 1933, pages 231-233; Sept. 1933, pages 295-297; Oct. 1933, pages 361-362. See *Metals & Alloys*, Vol. 4, May 1933, page MA 152. AWM (4c)

Manufacture of Bimetallic Tubes. P. S. MAYBORODA. *Tzvetnuie Metallui*, May-June, 1932, pages 37-48. (In Russian.) A description of a process for the manufacture of bi-metallic (Fe-Cu and duralumin-Al) tubes protected on both

8 inner and outer surfaces. BND (4c)

Shells Drawn from Rustless Steel. JOHN J. MCHENRY. *American Machinist*, Vol. 77, July 19, 1933, pages 460-461. A review of information dealing with rustless steel for deep-drawing operations; stages for the latter and best lubricating mixtures are given; frequent annealing is recommended. The dies for drawing should be of special alloys, those designated as Ziv's P.R.K., Carpenter's K. W. being recommended. Ha (4c)

Grain Size in Relation to Cold Working. A. L. MOLINEUX. *Metal Industry*, London, Vol. 43, Dec. 22, 1933, pages 609-612; Dec. 29, 1933, page 634. With discussion. The question was discussed if and how uniform, regular grain size

9 in Cu and brass sheet and wire can be obtained by annealing after rolling or drawing. Grain size can be controlled fairly well by temperature and duration of annealing but the method of annealing often prevents formation of uniform grains as the temperature inside and outside the coils which the material forms is too different or, if almost the same, the annealing time was too long for the outer layers. The value of uniformity was emphasized and better education of consumers urged; processes should be supervised by competent metallurgists. The actual size of the grain should be standardized for certain purposes. Ha (4c)

Tungsten Carbide Dies from the Mill Operator's View Point. W. ROY MACKAY. *Wire & Wire Products*, Vol. 8, Aug. 1933, pages 229-231, 243. Requirements of wire drawing dies regarding angle of approach, length of bearing, kind of

10 material, are discussed and the usefulness of tungsten carbide dies explained. A lubricant of 50% lime and 50% grease has proved of value. Pickling of the wire will contribute to the life of the die if the wire is left in the acid just long enough to loosen the scale and dissolve any red rust on the wire. The speed of drawing should not be so high as to heat the die unduly as its strength and hardness might be impaired. Ha (4c)

Machining (4d)

The Machineability of Screw Machine Stock. H. W. Graham. *Machinery*, N. Y., Vol. 39, Aug. 1933, pages 793-795. Discussion of the effect of tool sharpness, cutting speeds, and cutting depth on the structure of the metal. Contains several photomicrographs showing difference between good and bad machining. A chart shows the difficulty of establishing a table of comparative machineability of various steels because the performance differs greatly with the amount of metal removed. RHP (4d) 1

Recent Investigation of the Milling Process (Neuere Untersuchungen des Fräsvorganges) E. Broedner. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Oct. 14, 1933, pages 1113-1117. Influence of diameter, number of teeth and pitch of teeth upon the working of different materials is investigated. Average cutting forces decrease with decrease of number of teeth and diameter of miller. For the same number of teeth the average cutting forces increase about 10% for an increase of pitch from 35 to 55°. A nomogram is developed from which the most favorable width of the miller can be determined with which the tool cuts absolutely uniformly. A high pitch prevents "rattling," the number of teeth can be reduced and lower cutting forces and lower regrinding costs result. The best practice is to cut with fewer big chips than with many small chips, that is milling with high feed and small cutting depths with low cutting velocity. 27 references. Hap (4d) 2

Cutting Process with Rotating Tools (Il Processo di Recisione con Utensili Rotanti) E. Bugini. *L'Industria Meccanica*, Vol. 15, May 1933, pages 393-397. A theoretical discussion of the cutting process and the energy consumed by rotating cutters and the influence of the shape of the latter. A few examples are calculated. Ha (4d)

Multiple Drilling on Close Centers. E. Gerhardt. *Modern Machine Shop*, Vol. 6, Sept. 1933, pages 39-40. Describes a device for drilling 5 little holes on a ½° circle with a hole in the center. Ha (4d) 3

Performance of Cutting Fluids in Drilling Various Metals. O. W. Boston & C. J. Oxford. *Transactions American Society of Mechanical Engineers*, Machine Shop Practice Section, Vol. 55, Sept. 30, 1933, pages 1-29. Results of a series of drilling tests on 9 different metals using 11 different cutting fluids are given. Formulas for torque and thrust were developed and material constants derived. Savings of from 6 to 33% in power were made when oils of different kinds, lard, mineral, compounded or sulphurized oil were used for lubrication (dry drilling = 100% power consumption.) Ha (4d)

Accuracy in Airplane Propeller Making. I. F. H. Colvin. *American Machinist*, Vol. 77, Dec. 6, 1933, pages 773-776. Substitution of metal for wood propellers necessitated different methods for working. Tools, jigs, machining methods are described and illustrated. Ha (4d) 4

Adjustable Reamers. H. Bentley. *Metal Industry*, London, Vol. 43, Nov. 17, 1933, page 486. Adjustable reamers consisting of a series of loose blades on the reamer body and their performance are described. Ha (4d)

Milling and Shaping in the Small Shop. A. L. De Leeuw. *American Machinist*, Vol. 77, Sept. 13, 1933, pages 602-603. Selection of proper machines to be installed and several ways to use them is discussed with the view of getting the best use with the least equipment for small shops. Ha (4d)

Effect of Lathe Cutting Conditions on the Hardness of Carbon and Alloy Steels. T. G. Digges. *Mechanical World & Engineering Record*, Vol. 93, Sept. 1, 1933, page 832. The amount of hardening which appears in a machined surface is not affected by changes in cutting speed but is influenced by changes of feed or depth of cut for a given area of cut. The effect of annealing temperatures (100°-720° C.) on the surface hardness of some of the steels work hardened in the lathe tests are discussed with other results of tests. Kz (4d) 5

How Long between Grinds? Rob. C. Deale. *American Machinist*, Vol. 77, Aug. 16, 1933, pages 517-521. Some calculations are made which are to prove that each tool has a certain life under operating conditions before it is to be ground again which results in minimum cost per piece of work turned out; this varies with the kind of job and with local conditions. Examples are given and charts calculated showing the cost of a certain process for an assumed tool life. Hap (4d) 6

Tests for Metal-cutting Tools. R. C. Deale. *Mechanical World & Engineering Record*, Vol. 92, Nov. 18, 1932, pages 507-508. See *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 394. Kz (4d)

Precision Required in Machining Nickel-Steel Helical Gears. Burnham Finney. *Iron Age*, Vol. 131, Feb. 23, 1933, pages 308-309, adv. sec. page 12. Describes method used by the Packard Motor Car Co. in machining helical transmission gears. VSP (4d)

Grinding Cemented Tungsten- and Tantalum-Carbide-Tipped Tools Economically. J. M. Highducheck. *Transactions American Society of Mechanical Engineers*, Machine Shop Practice Section, Vol. 55, Sept. 30, 1933, pages 31-36. A grinding set up for large production is described. Ha (4d) 7

External Broaching. L. E. Bleicher. *American Machinist*, Vol. 77, Sept. 27, 1933, pages 623-624. Use of broaching as a finishing operation on external surfaces is recommended for much wider application; advantages and methods are described. Ha (4d)

Equipment Policies, Transmission Gears and Tooling Occupy Production Men at Three Sessions. Joseph Geschelin. *Automotive Industries*, Vol. 69, Aug. 26, 1933, pages 240-244. The writer discusses various phases of equipment and tooling purchases. He points out that these problems have been cleared up by means of executive and factory liaison. Tool costs and existing purchasing methods are entertained. DTR (4d) 8

Tungsten-Carbide Tools for Drilling Slate and Marble. J. M. Highducheck. *Machinery*, N. Y., Vol. 39, Feb. 1933, pages 407-408. Illustrates the design of tungsten-carbide tipped tools. Gives dimensions, speeds, blade angle, drilling time, and coolant used for these drills. RHP (4d)

Standardization of Cutting Tools and Their Designations (Zur Normung der Schneidstähle und ihrer Benennungen). Rich. Nerlich. *Feinmechanik und Präzision*, Vol. 41, Mar. 1933, pages 42-44. An attempt is made to supplement the German Standards for cutting tools with respect to faces and angles at the cutting edge which are, so far, not unambiguously defined for every cutting tool. The discussion starts from the fact that, in a good cutting tool, only its cutting edges must come in contact with the working piece as otherwise an injurious pressure is exerted on the latter. The different surfaces and angles between them and the work piece are defined by Greek letters and new names are designated for them. An internationally accepted regulation is suggested. Ha (4d) 9

Concentric Machining. Fred. Horner. *Mechanical World & Engineering Record*, Vol. 93, Sept. 22, 1933, pages 914-915. Review of latest methods of insuring concentricity in intricate parts subject to specified fine limits and interchangeability. Kz (4d)

How Electric Refrigerators are Made Noiseless. Charles O. Herb. *Machinery*, N. Y., Vol. 39, May 1933, pages 561-564. Largely a discussion of machining work done on high C tool steel pistons used in electric refrigerators. RHP (4d) 10

Important Factors in the Selection of Cutting Lubricants. H. C. Deckard. *Machinery*, N. Y., Vol. 39, Feb. 1933, pages 409-410. General discussion of factors including the following: 1. type of equipment, 2. method of distribution of coolant, 3. kind of material to be cut, 4. hardness of material, 5 chemical composition of the material, 6. operation to be performed, 7. chemical and physical qualities of the oil, 8. cutting speed and depth of cut. RHPp (4d)

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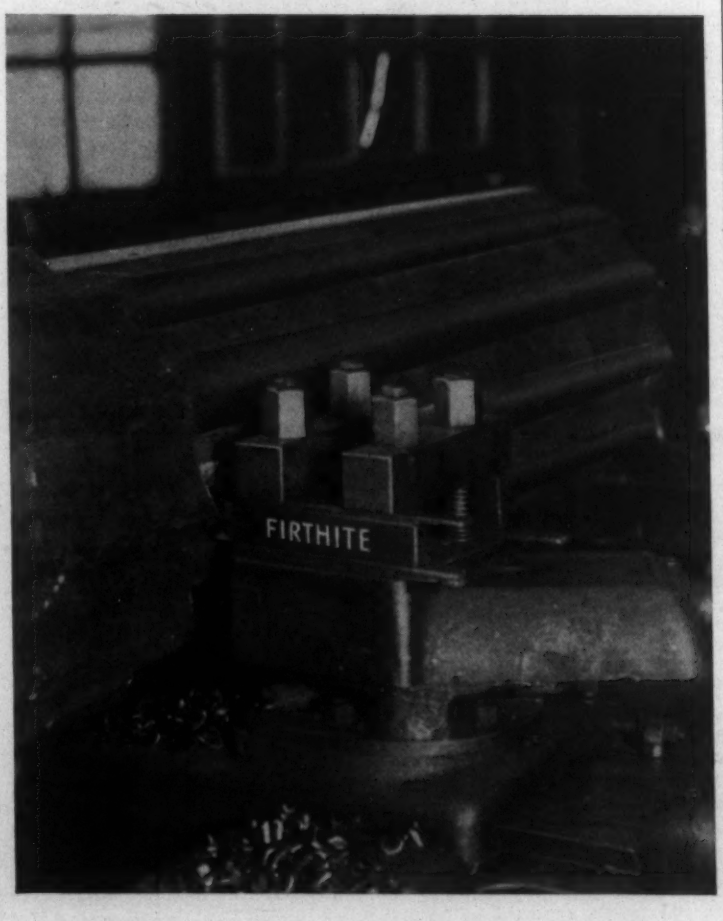

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Experiences in Machining Aluminum Alloys. R. V. Hutchinson. *American Machinist*, Vol. 77, Oct. 11, 1933, pages 645-647; Oct. 25, 1933, pages 686-688. Turning shaping, milling, boring, tapping and reaming and proper forms of tools for these operations are described, with special reference to aircraft construction. Ha (4d)

Factors Influencing the Production of Wheel Lathes. A. T. Kuehner. *Machinery*, N. Y., Vol. 39, June 1933, pages 666-667. Discusses design. RHP (4d)

Selecting the Right Cutting Tools in a Modern Machine Shop. J. M. Highducheck. *Machinery*, N. Y., Vol. 39, Sept. 1932, pages 30-32; Nov. 1932, pages 172-175. Tests of relative durability and cutting capacities of tungsten high speed steel, Co-W high speed steel, Stellite, Ta carbide and W carbide were made. Tools were ground at the beginning of each test and were run until they burned, the tip came off, or a piece of the cutting edge broke away. Four brands of each were tested, with the exception of Stellite. Table shows the cutting time and the number of cubic inches of material removed. Plain C steel of 1.10 to 1.20% C, maximum of 0.03% Mn, 0.02% P, 0.02% S, and 0.30% Si is well adapted for use in tools such as the following: (1) lathe centers and arbors, (2) mandrels, (3) counterbore pilots, (4) ring gages, (5) plug gages, (6) drill bushings, (7) gage pieces on milling fixtures, (8) collets (working ends only), (9) scrapers, (10) V-blocks, (11) cold punches, (12) punches for soft material, (13) knife blades and (14) screwdrivers. Tools from 1-10 should have a scleroscope hardness of 80-90; those from 11-14 should have a hardness of 70-80. Most high speed steel cutting tools contain 0.70% C, 4% Cr, 1% V, and 18% W. This steel will stand temperatures which are too high for plain C steel. It is used for cutting tools, milling cutters, gear hobs, counterbores, hardened die parts that can be readily ground, punches, end-mills, drills and reamers. These should have a scleroscope hardness of 80-90. Discusses advantages of Co high speed steel. Its hardness should be 80-90. Considers several specific applications of W carbide and the materials are brazed to the tool shank with a sheet of Cu about 0.003" thick. RHPp (4d)

Machining with Cutting Alloys and Metal Carbides (Bearbeitung mit Schneid- und Hartmetallen). M. Kurrein. *Maschinenbau*, Vol. 12, Feb. 2, 1933, pages 67-70. Comparison of the experiences published especially in the USA on the application of Stellite and some carboloys with the observations of the author and others. Particularly referring to the limitations of the fields of application of these two types of tools, to the blunting of the carbide tools, to tool design, shapes of the cutting edges, influence of the feed, actual gain in efficiency and to the peculiar advantages of the carboloys. Data of various firms are presented (Sellers, Kearney & Trecker, Warner & Swasey, Loewe-Gesfuerel). RV (4d)

Available Tool Steels Classified As to Brands and Types. Edwin F. Cone. *Iron Age*, Vol. 129, June 16, 1932, pages 1287-1298. The steels are arranged in 3 groups; one listing in alphabetical order the tool steel producers and agents, another in alphabetical order brands which include type of steel and determining element, with a key number to identify the producer or agent and a third to identify tool steels by types and applications. VSP (4d)

Fine Drilling. (Ein stehendes Feinbohrwerk.) *Die Werkzeugmaschine*, Vol. 37, Jan. 15, 1933, pages 7-8. Comments by Marx & Traube on Krause's former paper on above subject. (*Die Werkzeugmaschine*, Vol. 36, Sept. 30, 1932, page 339; Nov. 15, 1932, page 409.) Whereas Krause thinks that either piston rings should be rough turned or piston walls should have no smooth finish in order to attain proper lubrication Marx and Traube contend that automobile cylinders must have a high finish. GN (4d)

Hard Metal Alloys and Their Particular Properties for Production of Cutting Tools. (Ueber Hartmetallliegierungen und ihre besonderen Eigenschaften für die Herstellung von Schneidwerkzeugen.) *Das Werkzeug*, supplement to *Maschinenkonstrukteur-Betriebstechnik*, Vol. 8, Dec. 10, 1932, pages 139-140. Compares properties of cast and sintered hard metal alloys (Stellite and Widia) and shows where each is used to better advantage. GN (4d)

High Capacity Milling Cutters for Machining Light Metal. (Hochleistungsfräser zur Bearbeitung von Leichtmetall.) *Das Werkzeug*, supplement to *Maschinenkonstrukteur-Betriebstechnik*, Vol. 8, Dec. 10, 1932, pages 145-146. Some special types of milling cutters as they are required for machining light metals and light metal alloys are described. GN (4d)

Status of Knowledge of Chippability of Steel and Cast Iron. (Stand der Kenntnisse über die Zerspanbarkeit von Stahl und Gusseisen.) F. Rapatz. *Stahl und Eisen*, Vol. 52, Oct. 27, 1932, pages 1037-1045. Includes discussion. Workability can be estimated by amount of chips obtained (chippability), appearance of surface and energy consumed in machining. Estimation from quantity of chips is most important, permissible continual cutting rate for an hour serving as a measure. Deformation work, friction and rubbing effect of chips influence chippability, rubbing being dependent not only on strength but also on cold workability and hard constituents such as carbides. Tensile strength is decisive for cutting speeds attainable in turning of customary machine and refined steels. High alloyed steels are more difficult to machine than would correspond to their tensile strength while ordinary tool steels are easier. Cast Fe must be judged by its hardness. Admissible cutting rate for 1 hr. duration of turning permits drawing conclusions for 2 or more hours with sufficient accuracy. In drilling, contrary to turning, not only tensile strength, but also toughness is a determining factor which affects removal of chips, and therefore drilling. High speed and greater tensile strength facilitate formation of smooth surfaces in free turning provided cutting edge remains undamaged. Measurement of consumed energy or temperature of cutting edge is important for design of most economical shape of cutting edge and for detection of defects in cutting edge. Sometimes measurement of energy used or of cutting temperature permits a classification with respect to chippability. In discussion data are given obtained by such measurements. 19 references. Ha (4d)

Twist Drills and the Materials from which They are Made. W. R. Breeler. *Machinery*, Vol. 38, June 1932, pages 742-747. Typical analysis of C tool steel drills, C 1.20%; Mn 0.25%; P 0.015%; S 0.015% and Si 0.20%; sometimes 1% Cr. High speed steel, C 0.70; W 18%, Cr 4%, V 1%. By adding up to 12% C and 1% Mo a super high speed steel is produced. Discusses use of tungsten carbide, stellite, nitriding, and chromium plating edges for drills. Gives details of heat treating, tables of compositions, hardness, cutting speeds, feeds and operations between grinds. RHP (4d)

Fine-Drilling in Automobile Manufacture and Repair (Feinbohren im Automobilbau und in der Automobilreparatur) *Automobiltechnische Zeitschrift*, Vol. 36, June 10, 1933, pages 289-299. The fact that cylinders of automobile engines have a shorter life than most other parts of the automobile and have to be repaired or renewed is ascribed to the machining methods and nature of the cylinder surface. When drilling or turning the material is exposed to an additional lateral pressure instead of an axial pressure only, and when grinding particles of the grinding wheel are pressed into the surface which later injure piston and cylinder. A method by Krause is described by which the cylinder is drilled with the highest possible cutting velocity (100-130 m./min.) with only one free-cutting tool of hard metal without any lateral cutting pressure; the material is kept sound by the high velocity and the smallest feed of the tool. Machining must be done on heavy precision lathes without vibration. Only one process is required as this gives at once the accurate dimension. Ha (4d)

Performance of Molybdenum Alloy-Steel Hacksaw Blades. *Machinery*, Vol. 38, June 1932, page 763. Brief note giving speed and cost of cutting of a few articles. Does not mention percentage of Mo used. RHP (4d)

Results Obtained with Chromium-plated Cutting Tools. N. H. N. *Machinery*, London, Vol. 42, May 25, 1933, page 218. Widely varying results have been reported. One shop has secured 20 times the life of unplated drills or reamers by applying hard Cr to these tools, another lost money. These wide variations may be explained: (1) Many plating shops are not equipped to produce a satisfactory job of hard Cr plating. (2) When, for example, Cr has operated satisfactorily on drills 1 used on iron castings, it does not mean that Cr-plated tools should be satisfactory for machining cast iron in general. The important advantage of Cr is gained by having the chip bearing faces of the tool plated and not the edge. In general, Cr-plated tools have operated well, giving greatly improved performance on nearly all classes of materials. Dies for various applications show increased life after being plated with hard Cr. Kz (4d)

A Simple Cutting Tool for Measuring Pressures in the Direction of Cut. O. W. Boston & C. E. Kraus. *Transactions American Society for Steel Treating*, Vol. 21, July 1933, pages 623-651. **Machinability Measured by Simple Tool.** *Metal Progress*, Vol. 22, Sept. 1932, pages 29-33. Paper before the Buffalo Convention, A.S.S.T., Oct. 1932. A simple machinability testing tool and cut- 2 ting test data obtained with it are described. The device fits into the tool post of the lathe and measures by means of heavy springs and a dial gage, the pressure on the tool. Cutting tests with 2 different bits of different back and side rake and cutting angles at various depths on a low C steel are presented in a graph. They indicate that metal may be removed more efficiently with coarse feeds than with fine, and that depth of cut has little effect on efficiency. A formula relating cutting pressure with feed and depth of cut is given. Cutting tests on 9 different metals are presented graphically to show comparison with other methods of measurement to indicate the tool's accuracy. The same tests using the two bits above were conducted with 11 different cutting fluids to determine efficiency and the results are plotted on a graph. The cutting characteristics of malleable iron may be determined with this tool. Results of some tests on a malleable 3 iron are described. WLC (4d)

Machineability of Cast Irons. (Contribution a l'Étude de l'Usinabilité des Fontes.) Guy Hénon. *Bulletin de l'Association Technique de Fonderie*, Vol. 16, Aug. 1932, pages 458-465. Paper at World Foundry Congress, Paris, Sept. 1932. The sample is drilled under a feed load of 75 kg. by a carbon steel drill 10 mm. in diameter, rotating 350 r.p.m., for 60 seconds. The machineability number, U, is determined from the equation $U = K \frac{A_1}{A^1} \times 100$ where K is the ratio of the penetration depth in a chosen standard bar to 16 mm.; A_1 is the 4 average drill penetration in the sample under investigation; A^1 is the average drill penetration in the chosen standard bar. Various types of cast iron were investigated by this method. 21 references. WHS (4d)

Machinability of Cast Iron. (Usinabilite des Fontes.) G. Henon. *L'Usine*, Vol. 41, Oct. 7, 1932, page 31. Methods for determining machinability of cast Fe by hardness test, drilling, turning are discussed and explained. Velocities of tool depend on its nature, for C steel 8-12 m./min., high-speed steel 15-35 m./min., and for W carbides 60-100 m./min. are usual. Ha (4d)

Importance of Oils in Machining with or without Chipping. (Die Bedeutung der Oele in der spangebenden und spanlosen Formung.) K. Krekeler. *Oberflächentechnik*, Vol. 9, Nov. 15, 1932, pages 230-231. Oils used in milling, drilling, cutting and other machining processes play a great part in quality of surface 5 and accuracy of piece; production can be increased considerably with proper kind of oil. Requirements of mineral and fat oils with regard to cooling, corrosion, emulsification are discussed. Oil should be carefully supervised during operation in order to keep its quality, concentration and temperature as constant as possible. Ha (4d)

Contribution to Problem of Workability. (Beitrag zur Frage der Bearbeitbarkeit.) W. Melle. *Werkstattstechnik*, Vol. 26, Nov. 15, 1932, pages 437-439. Deals with testing workability of free cutting steel. The "Hardness-Drilling Method" was most reliable. Widia twist drills 10 mm. in diameter with a high cutting stability are used at a cutting speed of 20 m./min. and at a pressure of 35 kg. Drilling diagram of the machine illustrates the result. A correction table is added 6 which allows for small abrasion of drill. Comparative tests with other methods and with practical results in workshop were favorable. RFV (4d).

Hot Forming or Machining? (Warmpressen oder Zerspanen?) Otto Lich. *Das Werkzeug*, supplement to *Maschinenkonstrukteur-Betriebstechnik*, Vol. 8, Nov. 10, 1932, pages 125-126. Giving many examples, author compares the advantages in making various parts by hot forming and machining. GN (4d)

Increase of Cutting Speed and Formation of Flow Chips and Their Effect on the Surface Quality and the Machine Tool. (Schnittgeschwindigkeitserhöhung und Fliessspanbildung in ihrem Einfluss auf Oberflächengüte und Werkzeugmaschine.) Walter Reichel. *Zeitschrift für wirtschaftliche Fertigung*, Oct. 1932, section Met., 4 pages; Nov. 1932, section Met., 5 pages. Of decisive importance for every 7 machining process and the type of chip formation next to type and shape of the tool are the tensile and plastic properties of the material. Mathematical considerations of the forces occurring in various machining processes are given, flow, shear and tear chip and how they are affected by the angle under which the chip flows off and by the depth of cut are discussed. For all 3 types of chips the surface quality of the piece machined and tool life essentially depend on the built-up edge formed. As to this point the investigations by Schwerd and Schilken are particularly referred to. (See *Metals & Alloys*, Vol. 3, Jan. 1932, page MA 19, Schilken: Über den Einfluss verschiedener Bearbeitungsverfahren auf das Gefüge in der Randzone von Gusseisen.) The advantages of increased cutting speed for the improvement of the surface are considered, new types of machine tools which take into account this principle are described. They require special cooling devices. Of special interest are 8 the high speed fine drilling machines of the Krause Co., Vienna. The advantages of fine drilling are compared with other methods of making smooth bores, as grinding, honing, and lapping. High speed drilling gives smoothest surfaces and slightest distortion of the structure. GN (4d)

Drilling Tests on Steel. (Schneidversuche mit Gewindebohrern auf Stahl.) Hans Joachim Stoewer. *Stock Zeitschrift*, Vol. 5, Dec. 1932, pages 31-42. Results of an extensive investigation on suitable shape of drills are given. All factors affecting machining properties were studied by means of an especially designed apparatus which is described. Influence of cutting face, chip angle, number of slots, material drilled, back grinding of flanks, speed and pressure were studied. GN (4d)

New Automatic Lathe with highest Machining Capacity. (Ein neuer Drehautomat mit höchster Zerspanungsleistung.) O. P. van Steewen. *Glasers Annalen*, Vol. 9 111, Nov. 1, 1932, pages 71-74. Author describes new automatic lathe, system Mulka, as marketed by Loewe-Gesfürel Co., Berlin. Principle of machining differs from former constructions in that material to be machined is simultaneously worked by 4 tools arranged around piece to be machined. Feed of these tools does not take place in longitudinal but in radial direction. A disadvantage of the machine is that it is applicable only to working pieces having not more than 270 mm. turning length. For such pieces, however, turning time is shortened considerably. GN (4d)

Investigation into Cooling and Lubricating Properties of Cutting Liquids for Machine Tools. (Untersuchung von Schneidflüssigkeiten für Werkzeugmaschinen auf Kühl- und Schmiereigenschaften.) Walter Reichel. *Die Werkzeugmaschine*, Vol. 10 36, Nov. 30, 1932, pages 411-415. After dealing with physical occurrences which are of importance for cooling and lubricating properties of oils the rules for the evaluation of oils are developed and discussed. Above mentioned properties of oils are best tested by life tests of tools and surface condition of piece machined. It is shown how cutting speed can be increased or cutting pressure decreased by proper selection of cutting oils. 17 references. GN (4d)

HEAT TREATMENT (5)

O. E. HARDER, SECTION EDITOR

Hardening, Quenching & Drawing (5b)

Electromagnetic Superficial Hardening of Alloy (Durcissement Electromagnétique Superficiel des Alliages) G. MAHOUX. *Science et Industrie*, Vol. 16, Oct. 1932, pages 401-408; Nov. 1932, pages 459-469. Very important report concerning results of experimental tests. Originally, author had found that with suitable combination of moderate temperatures and electro-magnetic oscillations it is possible to improve superficial hardening of a Ni-Cr-Mo alloy steel through action of a mixture of ammonia gas and city gas. Following this finding, numerous tests have been made to find results obtainable by applying this process to various ferrous alloys. Those tests have dealt with carbon steels, austenitic steels, high speeds steels, ordinary and alloy cast Fe. Although those tests are not yet ended, it is today possible to accept that all ferrous alloys can be hardened. For obtaining the best results in each case it is necessary to select suitable experimental conditions. Hardness reached is not so high for cast Fe as for high speed steel. This hardness depends upon the kind of alloy and its state previous to hardening treatment. Hard layer formed is harder on a quenched steel without temper than on the same steel quenched and tempered although temperature of the furnace during hardening process is as high as that at which temper is performed. FR (5b) 1

Temper Brittleness (Zur Frage der Anlassprödigkeit) E. HOUDREMONT & H. SCHRADER. *Archiv für das Eisenhüttenwesen*, Vol. 7, July 1933, pages 49-59. Contains a good review of the literature on temper brittleness i.e., low impact resistance after tempering at about 500° C., particularly on slow cooling after tempering. There is also a very extensive series of original experiments consisting mainly of impact tests of carbon and alloy steels after prolonged tempering in the blue-heat region. In steels subject to temper brittleness the impact resistance kept going down as the time of tempering in the 500° C. region was increased to several days; after such prolonged tempering there was no difference in impact resistance between fast and slow cooling after tempering. Steels very sensitive to temper brittleness showed a reduction in impact resistance on heating to 500° C. and an increase in impact resistance on heating to 600° C. Medium-sensitive steels showed a lesser reduction in impact resistance at 500° C. and an appreciable reduction after heating at 600° C. Very slightly sensitive steels showed the same change in impact resistance at 500° and 600° C. It was concluded that temper brittleness is a precipitation phenomenon manifesting the usual effects of coalescence after dispersion, and that it is not due to decomposition of retained austenite. It was not possible to draw any conclusions as to the nature of the precipitated particles, whether they were carbides, oxides, nitrides, or phosphides. Both Mo and W tended to reduce the temper brittleness, Mo having the stronger effect. SE (5b) 2 3 4

The Temperature Atmosphere Problem in High Speed Steel. SAM TOUR. *Transactions American Society for Steel Treating*, Vol. 21, Mar. 1933, pages 269-288; *Iron Age*, Vol. 130, Oct. 13, 1932, pages 574-576. Effect of furnace atmosphere on structure of high speed steel at 2400° F. is discussed. Results of tests on ¾" bars of an 18-4-1 W high speed steel in a controlled atmosphere furnace with various atmospheres are presented. They indicate that the line AB of the pseudo-binary diagram of high speed steel by Grossmann and Bain is shifted by the furnace atmosphere. For low CO content the line is below 2400° F. and for 10% CO is above 2400° F. Without atmosphere control incipient melting may occur at 2400° F. Grain growth and scaling are also dependent on furnace atmosphere. Includes discussion. 9 references. VSP + WLC (5b) 5

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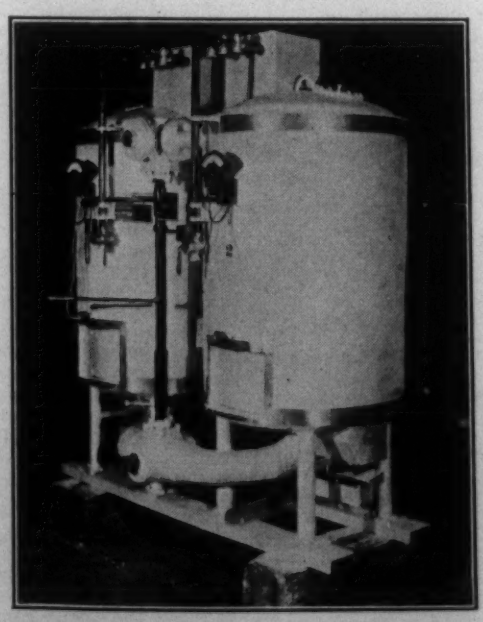

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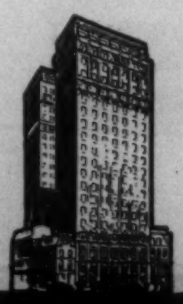

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Malleableizing (5d)

Graphitization of White Cast Iron (Ueber die Graphitisierung von weissem Gusseisen) A. Merz & H. Schuster. *Die Giesserei*, Vol. 20, Apr. 14, 1933, pages 145-151; Apr. 28, 1933, pages 173-181. Graphitization of white cast
1 iron is understood to be the decomposition of the iron carbide present in white solidified cast iron into its components according to $Fe_3C \rightarrow 3Fe + C$. Influence of temperature on graphitization in malleable iron was investigated. In agreement with previous investigators it was confirmed that annealing above A_1 point has no influence on the later graphitization of γ-solid solutions and that complete graphitization above pearlite temperature cannot be produced by any heat treatment in neutral atmosphere. A new "pendulum" annealing method (repeated heating and cooling) was developed whereby complete graphitization of malleable iron could be obtained in 24 hrs. It was found that to each temperature belongs a certain number of temper C nuclei; this number increases with temperature. Velocity of formation of nuclei is different for different temperatures, high for high and low for
2 low temperatures. Velocity of growth of the nuclei is definite for each temperature and increases with the latter; it is immaterial at which temperature the nuclei have been formed. Solution of C in γ-Fe follows definite laws; the solution velocity increases up to 950° C. linearly with temperature. Malleable iron made by the pendulum method showed a superiority in mechanical qualities and saving in time. 46 references. Ha (5d)

Carburizing (5e)

Investigations on the Surface Decarburization of Steel (Undersökningar rörande ytavkolning av stal) Arvid Johansson, R. von Seth & Niles Elfström. *Jernkontorets Annaler*, Vol. 116, Dec. 1932, pages 565-655. Equilibrium
3 isotherms have been determined for the systems $3\,Fe + 2\,CO \rightarrow Fe_3C + CO_2$ (I) and $3\,Fe + CH_4 \rightarrow Fe_3C + 2\,H_2$ (II) between 680° and 1100°. The isotherm for (I) at 710° shows a decreasing CO_2 pressure with increasing C content, a result which is inconsistent with the assumption that C is insoluble in ferrite below the Ac_1 point. Above 900° FeO can not be reduced to metallic Fe free from C. At 680° the reaction proceeded too slowly for establishing equilibrium but a mutual solubility of cementite and ferrite was indicated. From 900° to 1100° the activity coefficient of C was found to be nearly unity in cementite and Mn steels. By varying the CO_2-CO ratio in carburetted gas, either carburizing or decarburizing conditions may be established. At 1250° and 1320 the solubility of C in molten Fe was respectively 4.4% and 4.56%. In II, the rate of reaction
4 was found to be a maximum at 950° but was noticeable at 600° C., and falling again above 1000°. Ni, Mn, W, and Cr steels gave about the same rate as unalloyed steel. No decarburization was found with N_2 and none with air at 750°, 710°, or 650°, probably because a protective oxide layer prevents diffusion of gas to the Fe surface. 26 references. HCD (5e)

Problem of Heat Conduction, Applicable to the Diffusion of C in Steel (Ett värmeströmningsproblem med tillämpning pa kolets diffusion i stal) Hjalmar Granholm. *Jernkontorets Annaler*, Vol. 117, Jan. 1933, pages 14-21.
A graphical solution is given of the differential equation for the radial flow of heat in a cylinder. The method may be applied to the diffusion of C in cylindrical steel bars under carburizing or decarburizing conditions, in which case the calculations
5 may be simplified, if the diameter is not too small. HCD (5e)

Nitriding (5f)

First Technical Application of Nitriding Cast-iron. The Nitriding of Automobile cylinders (La prima applicazione tecnica della nitrurazione della ghisa. La nitrurazione dei cilindri per motori) F. Giolitti. *La Metallurgia Italiana*, Vol. 25, July 1933, pages 485-501. An outline of the industrial nitriding of automobile cylinders, now a commercial process. Choice of materials, and description of equipment used is included. AWC (5f)

Nitriding Steels (Gli accial da nitrurazione) F. Giolitti. *La Metallurgia*
6 *Italiana*, Vol. 25, Mar. 1933, pages 157-166. Summary of 4 types of steels used commercially for nitriding. Type 1 includes the steels requiring maximum surface hardness, and contain Cr, Mo, Al (1% Al). Type 2—steels which either must be low in carbon or are accidentally low in this element (less than 0.1%); they contain Cr, Ni, Mo. Type 3—those steels which were formerly tempered, i.e., the nitrided surface cannot be brittle, yet the surface must be tough; they contain less than 0.5% Al, or even none at all. Type 4—extra hard steels; these contain over 0.5% C. AWC (5f)

Double Nitriding (Doppelnitrierung) O. Hengstenberg & F. N. Naumann. *Archiv für das Eisenhüttenwesen*, Vol. 7, July 1933, pages 61-66; *Technische*
7 *Mitteilungen Krupp*, No. 2, 1933, pages 47-53. Hardness tests on tapered sections through the nitrided layers of 4 nitriding steels were made. The steels were nitrided in ammonia at 480°, 500°, and 520° C. respectively. The tests showed that nitriding first at a lower temperature and then at a higher increased the thickness and strength of the nitrided layer, without reducing the hardness appreciably, so long as the second nitriding temperature was not high enough to coalesce the nitrides too much. A second nitriding at a lower temperature than the first was without benefit. Ha+SE (5f)

Nitriding (Beitrag zur Kenntnis des Nitrierhärtungsverfahrens) W. Liestmann. *Archiv für das Eisenhüttenwesen*, Vol. 7, Aug. 1933, pages 131-139.
Powdered iron and a nitriding steel of 0.25% C, 1.1% Al, and 1.4% Cr were
8 nitrided in ammonia at 500° C., and the gas-metal reactions studied. A surface nitride layer on the iron was formed by the gas phase, the iron nitride in turn forming the base for further nitrogen penetration. In the nitriding steel the stable Al and Cr nitrides, on the other hand, did not forward the penetration of nitrogen by taking on and then giving off nitrogen. The breakdown of ammonia was 50 to 60% less in the nitriding steel than in the iron powder. In the nitriding steel the nitrogen enters the outer zones through nitriding of the grain boundaries and through the formation of needle-like lamellae. This is the structure in the region of highest hardness. Fine segregates probably resulting from dispersion and coalescence were observed only after lengthy nitriding in the inner layers of the normalized nitriding steel. The needles grow from the grain boundaries and result from the formation of iron nitride. It was not possible to shorten the nitriding period by introducing
9 catalysts in the nitriding chamber. SEp (5f)

Processes to Improve Surface Resistance of Crankshafts against Wear (Ueber Verfahren zur Erhöhung des Oberflächenverschleisswiderstandes von Kurbelwellen) H. Kallen & H. Schrader. *Technische Mitteilungen Krupp*, No. 2, 1933, pages 58-65; *Automobiltechnische Zeitschrift*, Vol. 36, Oct. 10, 1933, pages
484-490. 3 methods are applied to increase the hardness and wearing qualities of crankshafts which can be characterized as follows: (1) hardening by nitriding gives highest surface hardness, greatest wearing resistance and simple manipulation in the process; (2) case-hardening produces a lower surface hardness with good wearing resistance; the process requires, however, great experience; (3) special hard bearing process, where only the parts in the bearing are hardened by heating with acetylene
10 blow-torches during rotation of the crankshaft at high speed and local quenching; this produces lowest surface hardness but is generally sufficient as the crankshaft ni a modern motor is supported in such satisfactory manner as to exclude any additional stresses besides normal dynamic and static stresses so that wearing resistance is the main consideration. This method requires little time but careful treatment. Which method should be applied will depend on the kind of shaft and also on economical considerations in the factory. Ha (5f)

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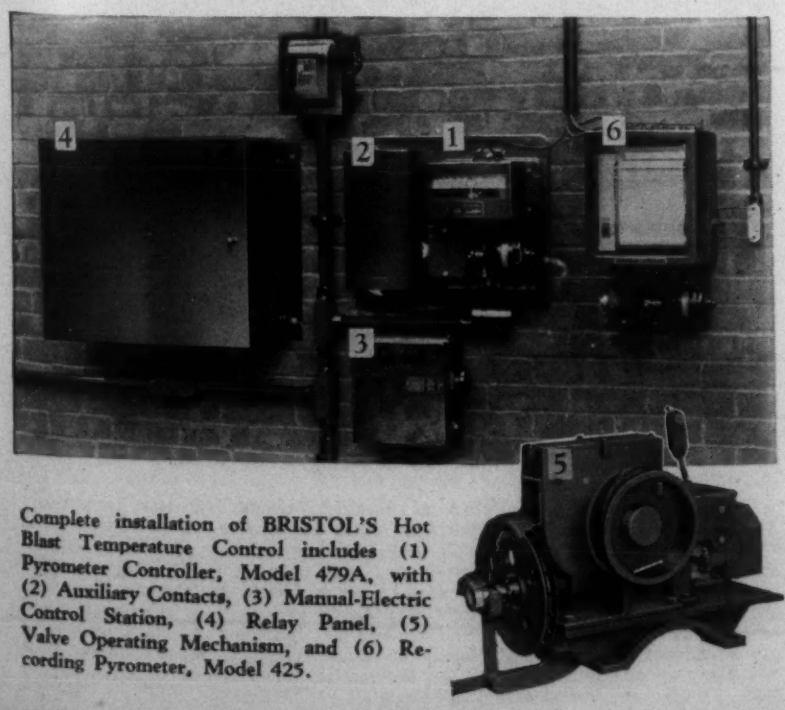

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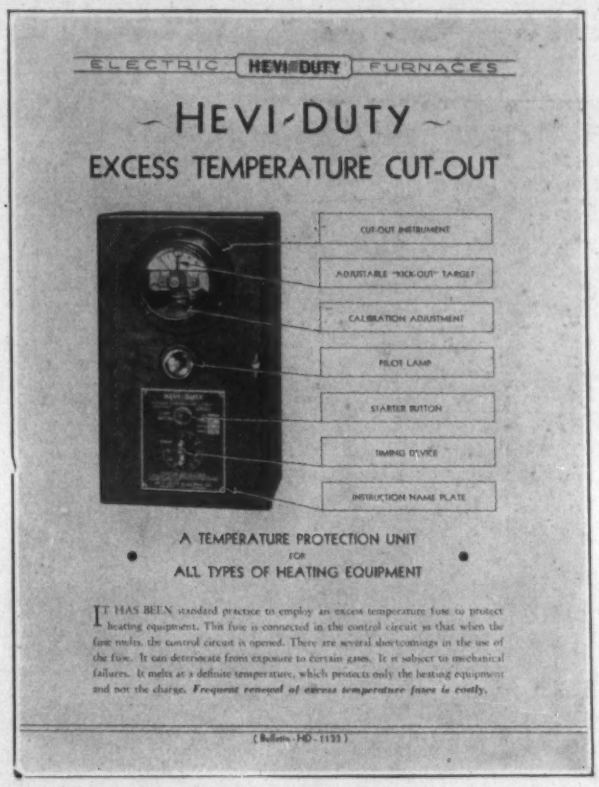
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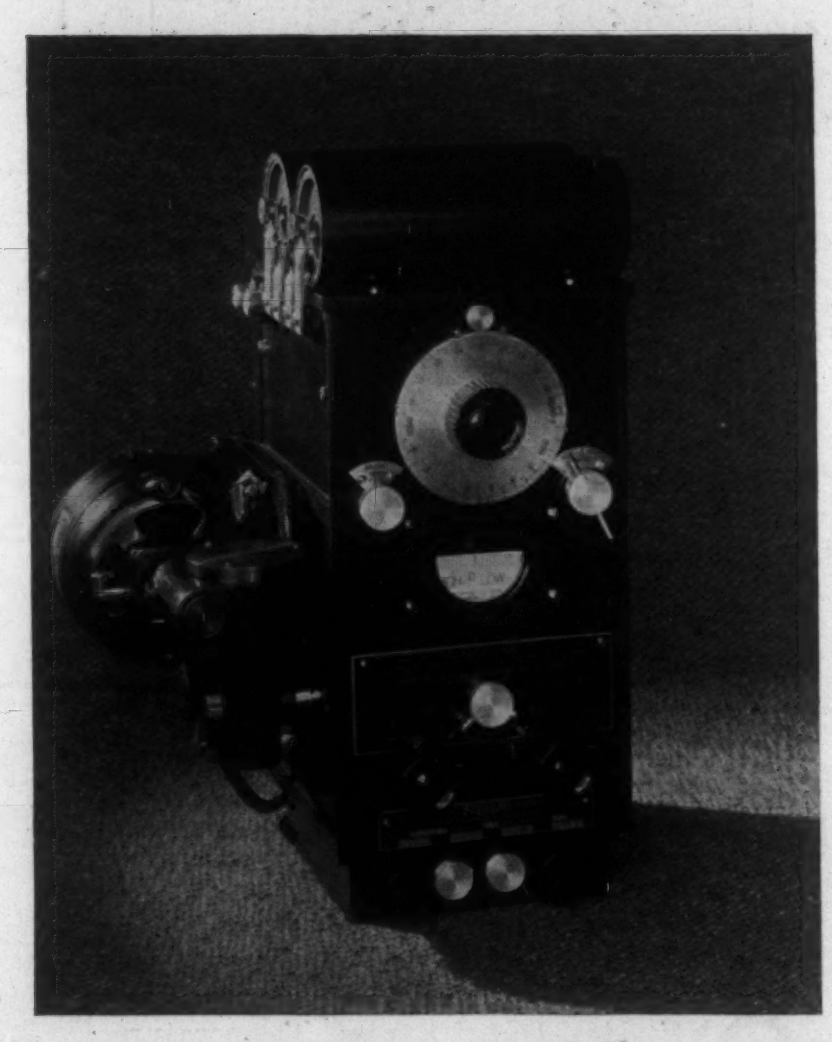

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THE COMPASS OF INDUSTRY

FURNACES, REFRACTORIES & FUELS (6)

RICHARD RIMBACH, SECTION EDITOR

1 **Ascertaining the Saving in Gas through Preheating (Anhaltszahlen für die Gasersparnis durch Vorwarmung)** G. NEUMANN. *Archiv für das Eisenhüttenwesen*, Vol. 7, July 1933, pages 37-39. Charts and tables illustrate the percentage saving of gas through preheating the air and gas in various types of heating. SE (6)

— **Reaction Capacity of Coke at Temperatures above 1000°C. (Die Reaktionsfähigkeit von Koks bei Temperaturen über 1000°)** HANS BROCHE & H. NEDELMANN. *Stahl und Eisen*, Vol. 53, Feb. 9, 1933, pages 144-147. Determinations of the velocity of reaction of coke which was formerly made below 1000° C. only, were made at actual blast-furnace temperatures from 1500° to 2000° C. The differences in the combustibility found for lower temperatures disappeared almost entirely at the high temperatures. Ha (6)

2 **Production of Water Gas in the Coke Oven (Wassergaserzeugung im Kcksofen)** G. LORENZEN. *Stahl und Eisen*, Vol. 53, Jan. 12, 1933, pages 33-40. The production of water gas in the coke oven can be of advantage for obtaining gas especially rich in H, increasing the gas output and controlling the heating value of the gas. Ha (6)

— **Unusual Heating Unit.** CHARLES LONGENECKER. *Heat Treating & Forging*, Vol. 19, Sept. 1933, pages 21-22. At Boulder Dam, a car-bottom type of furnace is used for relieving stresses in electrically-welded pipe. Inside dimensions are length, 41 ft., width, 36 ft., and height from top of car to roof, 29 ft. Heat transfer to material is by convection. Oil is burned in a combustion chamber entirely outside the furnace and the products of combustion are mixed with the cooled waste gases withdrawn from the furnace. Gases are circulated by a fan, capable of changing the furnace atmosphere every 40 seconds. Direction of travel of gases is changed by means of an electrically-operated, vertical butterfly valve, usually at 5-minute intervals. About 700 gallons of oil are required for heating a 150-ton charge to 1200° F. Maximum allowable temperature variation at any time is ± 20° F. MS (6)

— **Silite. II. Heating Elements (Ueber Silit. II. Heizstäbe)** FR. J. MANN. *Siemens-Zeitschrift*, Vol. 13, July/Aug. 1933, pages 155-158. Cylindrical rods of silit, a ceramic material, are used up to 1400° C. The specific electric resistance lies between 1000 and 2000 ohm/mm.^{2}; the temperature coefficient up to 900° C. is always negative, above 900° either weakly positive or negative. To get a reliable terminal for cable connections the ends of the rods are thickened. The material is also used for muffles. Silit is resistant against reducing gases; 4 acid vapors and air above 1200° attack the material very slowly; pure 0 effects more rapid oxidation. Ha (6)

— **Bright Annealing Furnace.** J. S. MURDOCH. *Heat Treating & Forging*, Vol. 19, Sept. 1933, pages 25, 22. For bright annealing of Cu and brass tubing, Chase Brass & Copper Company has installed at its Cleveland plant an electric furnace with an artificial atmosphere obtained by partially cracking natural gas. Over-all length is 97 ft., over-all height is 7½ ft., and width is graduated, being 6 ft. at the widest point. Heating chamber is 18 ft. long. Cooling chamber and hoods occupy remainder of space. There are 2 heating zones, a range of 1000°-1200° F. being used. MS (6)

5 **Metallurgical Coke.** R. A. MOTT. *Iron & Steel Industry & British Foundryman*, Vol. 6, Feb. 1933, pages 193-195. Historical developments in the coking of coal and the properties of coke as they affect blast furnace and foundry practices are described. Chief requirements are purity and hardness, though the requirements in both practices are not the same. For blast furnace purposes cokes of high reactivity are less desirable than cokes of low reactivity. CHL (6)

— **Use of Electric Furnaces for Heat Treatment and Melting of Metals (L'Emploi des Fours électriques pour le Traitement thermique et la Fusion des Metaux)** ANDRÉ MIEG. *Revue Générale de l'Electricité*, Vol. 34, Sept. 9, 1933, pages 329-330. Advantages of resistance furnaces for heat treatment and induction furnaces for melting are briefly discussed. Ha (6)

6 **Construction of Furnace Walls, Hearths, Doors, and Other Parts.** F. H. NORTON. *Fuels & Furnaces*, Vol. 11, May/June 1933, pages 86-96. Description and review of methods of designing foundations, walls, arches, doors and other constructive details. Tables of standard shapes of arch bricks, key bricks, blocks, etc. are given. Ha (6)

— **Refractory Shapes for Industrial Furnaces.** F. H. NORTON. *Fuels & Furnaces*, Vol. 11, Sept./Oct. 1933, pages 166-170. Standard shapes of refractory building material for furnaces, and their satisfactoriness are discussed; suggestions are made for changes which would tend to reduce cost of material and especially labor in assembling a furnace. A few special shapes, often needed to form openings or a good interlock are illustrated. Ha (6)

7 **Furnace Roofs.** F. H. NORTON. *Fuels & Furnaces*, Vol. 11, Mar./Apr. 1933, pages 54-63. Construction, calculation of the various types (arch, dome, suspended roofs, etc.), and materials used are discussed. Tables of practical figures for calculation and sketches of design are given. Ha (6)

— **Use of Cements, Coatings and Plastics in Furnace Construction.** F. H. NORTON. *Fuels & Furnaces*, Vol. 11, July/Aug. 1933, pages 125-134, 148. Analyses, characteristics and methods of applying cements, coatings and plastics for laying new brickwork or repairing and patching are discussed and the principal considerations pointed out which determine the choice of material. Ha (6)

8 **Improving the Coking Performance of Weakly-caking Coal.** R. A. MOTT & R. V. WHEELER. *Iron & Steel Institute*, Advance Copy No. 11, Sept. 1933, 17 pages; *Iron & Coal Trades Review*, Vol. 127, Sept. 15, 1933, pages 385-387. Weakly caking coals are weakly swelling coals. Those studied contained on a dry ash-free basis less than 83% C and 5% or more H. Coke from such coals can be improved by top-charging the ovens instead of cake-charging. A further improvement can be obtained by blending about 3% charcoal dust or coke dust with the charge. For a hard or non-abradable coke the coal should be mixed with — 20-30% of a strongly swelling coal. Another method of improvement that offers considerable promise is the treating with 3 or 4% coke-oven tar. Details regarding this will be published later. Ha + JLG (6)

9 **Recent Developments in Design of Electric Furnaces for low Temperatures (Neuere Entwicklung im Bau elektrischer Oefen für niedere Temperaturen)** J. E. ORAM. *Elektrowärme*, Vol. 3, June 1933, pages 122-124. Furnaces operating at temperatures between 200°-450° C. are improved by agitating the air in the furnace which reduces the time of bringing the charge up to temperature as at these low temperatures heat is transmitted almost exclusively by convection instead of by radiation as in high temperature furnaces. Examples are described showing the arrangement of centrifugal blowers to achieve this end. In this manner it is — not necessary to clean the goods as is necessary when heated in a salt or oil bath. Temperature control is of importance. Ha (6)

10 **Present Status of Purification of Blast-Furnace Gas (Ueber den Stand der Hochofengasreinigung)** K. GUTHMANN. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Feb. 18, 1933, pages 173-176. The various processes of purification of blast-furnace gas necessary for further use are reviewed and recent developments described; use in gas machines, boiler houses, etc., requires a purity of a maximum of 0.02 g. dust particles in 1 m.^{3} gas. Dry, wet and electrofilter installations are discussed and figures for the performances of different cleaners are given, the kind of dust is of great importance on the degree of cleaning. An advantage of the electrical cleaning method is that practically no loss of pressure is involved. 5 to 10 mm. W. G. maximum. Ha (6)

Electric High-Temperature Furnaces with Metallic Heating Elements (Elektrische Hochtemperaturöfen mit unedlen metallischen Heizleitern) F. LAUSTER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, July 1, 1933, pages 696-697; *Elektrowärme*, Vol. 3, July 15, 1933, pages 212-213; *Engineering Progress*, Vol. 14, Aug. 1933, pages 157-158. A new alloy for heating elements is described which is composed of 30% Cr, 5% Al, the remainder mainly Fe, and has about the same low temperature coefficient as Cr-Ni alloys but can be used up to 1250° C. (2300° F.); it is therefore particularly suited for heat treating furnaces. The specific resistance of this material, "Megapyr," is higher than that of Cr-Ni while its specific gravity is less. Its surface load can be higher than for Cr-Ni. A few applications in furnaces are described. RHP + Ha (6) 1

Flow Phenomena in Hearth Chamber of an Open-Hearth Furnace (Strömungsvorgänge im Herdraum von Siemens-Martin-Oefen) F. KOFLER & G. SCHEFELS. *Stahl und Eisen*, Vol. 53, Feb. 16, 1933, pages 162-167. To study the combustion conditions over the hearth the distribution of flame and gas velocity in the chamber was measured in a 70 ton furnace, the pressure was determined by water-cooled orifices. On the basis of the results suggestions are made for possible improvements in the guiding and directing of the flame. Curves showing the relations of temperature, velocity and sp.gr. of gas and air for design and evaluation of results are explained. Ha (6) 2

A Molybdenum-resistance Furnace of New Design. G. BURROWS & F. L. CLARK. *Journal of Scientific Instruments*, Vol. 10, Aug. 1933, pages 248-250. Description of a furnace for carrying out gas reactions at temperatures approaching 2000° C. The design utilizes molybdenum-resistance strips as heating elements. RAW (6)

Insulation of Open Hearth Furnaces. E. F. ENTWISLE. *Preprint American Iron & Steel Institute*, May 1933, 12 pages; *Foundry Trade Journal*, Vol. 49, Aug. 31, 1933, page 120; *Fuels & Furnaces*, Vol. 11, May-June 1933, pages 105-110. A general discussion of the problems involved in the insulation of open hearth furnaces. VVK + OWE + Ha (6) 3

Temperature Control of Commercial Furnaces of Different Heat Capacity (Die Temperaturregelung technischer öfen bei verschiedener Wärmekapazität) C. HIMMLER. *Die Wärme*, Vol. 56, Sept. 16, 1933, pages 598-602. The accurate maintenance of a certain furnace temperature depends on the heat capacity of the furnace. In case of large heat capacities, good results are secured by controlling the heat supply by steps. Furnaces with low heat capacities and considerable difference between the temperature of the heating unit at one hand and the temperature of the work in the furnace at the other hand, should be operated by regulating continuously the entire heat supply. In this case the effect of direct heat conduction into the material in the furnace must be eliminated. Thus the control apparatus operates on the basis of an "energy equilibrium device," in which temperature and energy supply are utilized as control factors. EF (6) 4

Inefficiency of Large Cupola Furnaces and Its Improvement (Die Unwirtschaftlichkeit grosser Kupolöfen und ihre Behebung) TH. EHRHARDT. *Die Giesserei*, Vol. 20, May 26, 1933, pages 218-222. It is pointed out that large cupola furnaces, that is those with iron capacity of 6 tons/hr. or more, do not operate as efficiently as smaller ones due to inordinately great height and diameter of the furnace, excessive wind-pressure and energy consumption. A more efficient operation is suggested by proper shape of the section of the furnace, especially an elliptical form, further changing the furnace in such a manner that coke and material are well distributed over the whole section, not only near the charging end. Ha (6)

Fundamental Principles of Galvanizing Furnace Design. WALLACE G. IMHOFF. *Fuels & Furnaces*, Vol. 11, July/Aug. 1933, pages 135-138, 148-149. The combustion of gaseous fuels for galvanizing furnaces, their proper mixture with air, burners, directing the flame for full utilization of heat and principles of heat transmission is discussed exhaustively. Ha (6) 5

Individual Construction Parts of Ingot Soaking Pits (Ueber Einzelbauteile von Blockwärmöfen) J. G. HEER. *Stahl und Eisen*, Vol. 53, Jan. 12, 1933, pages 40-43; Jan. 19, 1933, pages 75-77. Construction details of a soaking pit and 2 ingot furnaces are described with special reference to doors and arrangement of burners. Ha (6)

Segregators for Cupola Furnaces and their Calculation (Schlackenabscheider an Kupolöfen und ihre rechnerische Erfassung) K. IRRESBERGER. *Die Giesserei*, Vol. 20, June 9, 1933, pages 240-242. Methods for the removal of slag are discussed, several constructions described and a way is shown for the design of such installations. Ha (6) 6

Rim Heating (Felgenheizung) O. JUNKER. *Elektrowärme*, Vol. 3, 1933, pages 218-220; *Metal Industry*, London, Vol. 43, Nov. 1933, pages 387-389. To improve the ratio of heating surface of the heating elements to surface of the furnace walls the elements are shaped like the rims of a wheel and made rigid by ribs or corrugations so that they need not be embedded in the wall or held by clamps, etc. The whole surface may almost be covered with the elements producing in this manner a very uniform temperature distribution in the furnace. Ha (6)

Combustion Velocity of Gases and Gas Mixtures (Zündgeschwindigkeit von einfachen Gasen und Gasmischungen) F. KOFLER. *Stahl und Eisen*, Vol. 53, Jan. 5, 1933, pages 19-21. Useful tables and curves are given showing ignition temperatures, combustion temperatures and combustion velocities of gases used in metallurgical processes. A convenient method for calculating these speeds is at present still lacking. Ha (6) 7

Quantity of Air, Coke Charge and Melting Capacity of Cupola Furnaces (Windmenge, Kokssatz und Schmelzleistung bei Kupolöfen) HELLER & JUNGBLUTH. *Die Giesserei*, Vol. 20, Mar. 17, 1933, pages 114-115. The melting capacity of a cupola furnace in relation to other factors can be expressed by the formula $S=600xW/LxKxk$ where S is amount of Fe in tons melting down per hr., W amount of air blown into the furnace in m^3/min., L air in $m.^3$ required per kg. C, K amount of coke in kg. required per 100 kg. Fe, k amount in kg of C contained in 100 kg. coke; further, L is a direct function of the combination ratio $100\ CO_2/(CO_2+CO)$. It develops that L is dependent on the product Kxk, and the hourly melting capacity is directly proportional to the air per min. and inversely proportional to the quantity of coke burnt by the air. Ha (6) 8

Rocking Indirect Arc Electric Furnaces. E. L. CROSBY. *Electrical Engineering*, Vol. 53, Jan. 1934, pages 132-138. The electric furnace of the rocking type with indirect arc can now be used in the production of castings of various types of iron and steel with accurate control. This permits many new cast irons with properties vastly superior to the cast iron produced by other means. WHB (6)

Utilization and Significance of Electrical Heat in Industry (Die Anwendung und Bedeutung der Elektrowärme in Industrie und Gewerbe) KNOOPS. *Die Wärme*, Vol. 56, July 15, 1933, pages 454-458. Deals with resistance furnaces for melting, annealing, hardening, forging, drying and enamelling purposes and reports on arc and induction furnaces for melting of Fe and non-ferrous metals. Five tables are presented which compile service data on consumption of electrical energy. Advantages of electric heating are pointed out. EF (6) 9

Luminous versus Non-Luminous Flame for the Open-Hearth. V. BALABANOV. *Blast Furnace & Steel Plant*, Vol. 21, July 1933, pages 362-363, 381; Aug. 1933, pages 424-425; Sept. 1933, pages 476-477, 482. Outlines the fundamental principles of heat transfer in the open-hearth furnace and gives an example of the method of calculating the rate of heat transfer. Discusses the part played by convection. Compares the rates of heat transfer for both types of flame. Concludes that due recognition has not been paid to convective heat transfer from the flame to the open-hearth bath; the rate of this type of heat transfer can be increased greatly, with a resultant general improvement in the efficiency of the furnace and process; by using special burners for securing this increase, preheating of the gas can be eliminated in some cases; and cold and non-luminous gas could be used successfully without being carbureted. MS (6) 10

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1 **Time Required for Heating Steel. Pt. I-II.** J. D. KELLER. *Heat Treating & Forging*, Vol. 19, Nov. 1933, pages 65-66; Dec. 1933, pages 100-101. 8 references. Purpose is to attempt to simplify the theoretical methods of calculating the time required to heat steel to a given temperature in a furnace; to so modify them that they will fit the conditions of the actual problem as closely as possible; and to correlate and compare them with all available test data. Deals first with the properties of steel which must be considered, these being the capacity of its surface for absorbing radiated heat, its conductivity, its specific heat, and a latent heat occurring in the critical range, around 1350° F. Assumes that only radiation is active but increases the coefficient slightly to take care of convection. Considers next the manner in which heating proceeds, and shows that there are 5 stages. Presents and explains the use of curves showing the time required to heat flat mild steel plates up to 12" in thickness for furnace temperatures of 1400°-2400° F., the plates being exposed to radiation from both sides. Curves are based on a radiation coefficient equal to 60% of that of the ideal black body and on the assumption that the difference between furnace temperature and average steel temperature at the end of heating is 0.5% of the furnace temperature. For thick plates, additional provision is that temperature inequality in the metal does not exceed 0.5% of the furnace temperature. MS (6)

2 **Notes on the Utilization of Blast-furnace Gas.** W. B. BAXTER. *Iron & Steel Institute, Advance Copy* No. 3, Sept. 1933, 31 pages; *Blast Furnace & Steel Plant*, Vol. 21, Nov. 1933, pages 593-594; *Iron & Coal Trades Review*, Vol. 127, Sept. 15, 1933, pages 380-381. The uses of blast furnace gas at the works of the Appleby Iron Co. are described in detail. Appendices I to VII give the results of tests of the blast furnace gas in the various furnaces in the steel plant. JLG + MS + Ha (6)

3 **High-Frequency Melting Furnace (Hochfrequenzschmelzofen)** H. BECKMANN. *AEG Mitteilungen*, July 1933, pages 111-115. Principles and construction details are discussed; at present furnaces for an energy consumption up to 40 kw. are used with 20,000-10,000 cycles/sec., 40-300 kw. with 3000-1000 cycles/sec., and above 300 with 1000-350 cycles/sec. The higher frequencies are employed for materials with high specific resistance, as Fe, Ni, etc., while for Cu and Cu alloys the low frequencies in each group are used. Generating and control apparatus are described. Ha (6)

4 **Properties of Fire-proof Materials (Eigenschaften feuerfester Baustoffe für Dampfkesselfeuerungen)** W. MIEHR. *Die Wärme*, Vol. 56, July 29, 1933, pages 492-495. Discussion on and 11 most important physical properties of the following heat resistant materials: chamotte (10-45% Al_2O_3 + 88-52% SiO_2); silica (95% SiO_2); magnesite (84-88% MgO + 45-10% Fe_2O_3); Cr ore (40-43% Cr_2O_3); Si carbide (50-90% SiC); bauxite (60-70% Al_2O_3); corund (65-92% Al_2O_3); mullite (70-90% sillimanite); spinell (~ 75% Al_2O_3 + 13-15% MgO) and zirconium (~ 70% ZrO_2). EF (6)

5 **Refractory Linings for Coreless Induction Furnaces (Die feuerfeste Zustellung für kernlose Induktionsöfen)** H. SIEGEL. *Siemens-Zeitschrift*, Vol. 13, July/Aug. 1933, pages 147-150. The lining is made separately in form of a crucible for small furnaces, while directly in the furnace for large furnaces. Materials selected must be insensitive to temperature changes. Sinter magnesite with about 3% clay has given satisfactory results. The process of making the lining and its treatment before the first melt are described. Ha (6)

6 **Comparison of Single and Multiple Zone Hot Blast Stoves (Vergleich von Ein und Mehrzonenwinderhitzern)** F. KOFLER & J. W. GILLES. *Stahl und Eisen*, Vol. 53, Apr. 20, 1933, pages 393-397. In blast furnace operation high and uniform blast temperature had a favorable effect on coke consumption and Mn loss. Hot blast stoves giving a hot blast with little temperature reduction during reversals are, therefore, desirable. This is attainable by using triple zoned checkers as recommended by the Vereinigte Stahlwerke, A.G., Charlottenhütte. SE (6)

7 **Calculations for Pusher-Furnaces. Parts I & II (Die Berechnung von Stossöfen, Teil I & II)** W. HEILIGENSTAEDT. *Archiv für das Eisenhüttenwesen*, Vol. 7, July 1933, pages 25-36; Aug. 1933, pages 103-112. Calculations of heat consumed in bringing ingots up to 1300° C. are given. Formulae are developed taking into account relation between performance and waste gas temperature, furnace temperature, hearth losses, and heat consumption under various loading conditions. SE (6)

8 **Dependence of the Electric Resistance of Silicon Carbide Containing Heating Elements on Temperature (Abhängigkeit des elektrischen Widerstandes siliziumkarbidhaltiger Heizleiter von der Temperatur)** L. NAWO. *Elektrowärme*, Vol. 3, June 1933, pages 133-135. Investigations with commercial SiC resistances (silite, quarzilite, globar) show a fairly heterogeneous structure. The electric resistance lessens up to 700° C., the more so the greater the specific resistance of the element at room temperature. In the temperature range above 700° C. 2 kinds of heating elements must be distinguished. One type assumes a permanent increase in resistance at 700° C. or the resistance remains almost constant; a decrease of resistance does not take place. The resistance above 700° C. increases the more the lower the specific resistance at room temperature. This was especially the case in elements with large SiC crystals. The second type increases its resistance from 700° to 1200° C. and then decreases again, or a permanent appreciable decrease of resistance takes place at 700° C. It is not possible to give a generally applicable formula for calculating the resistance as SiC is not a uniform material but a mixture of crystals and amorphous material. The change of resistance with temperature is due very likely to a growth of the SiC crystals. Ha (6)

9 **Improving Open-Hearth Furnace Design.** WILLIAM C. BUELL, JR. *Steel*, Vol. 91, Oct. 3, 1932, pages 22-26, 30; Oct. 10, 1932, pages 23-26; Oct. 17, 1932, pages 24-26, 32; Oct. 24, 1932, pages 29-31; Oct. 31, 1932, pages 24-26; Nov. 7, 1932, pages 36-37; Nov. 14, 1932, pages 28-29, 31-32; Nov. 21, 1932, pages 26, 28-29, 31; Nov. 28, 1932, pages 28-29; Dec. 5, 1932, pages 29-30, 32; Dec. 12, 1932, pages 29-31; Dec. 19, 1932, pages 26, 28-29; Dec. 26, 1932, pages 22, 24-26; Vol. 92, Jan. 9, 1933, pages 21-22; Jan. 16, 1933, pages 20-21; Jan. 23, 1933, pages 21-22; Jan. 30, 1933, pages 28-29; Feb. 6, 1933, pages 36-37; Feb. 13, 1933, pages 24-25; Feb. 20, 1933, pages 27-28; Feb. 27, 1933, pages 24, 26; Mar. 6, 1933, pages 25-26; Mar. 13, 1933, pages 31-32; Mar. 20, 1933, pages 29-31; Mar. 27, 1933, pages 28-30; Apr. 3, 1933, pages 29-30, 32; Apr. 10, 1933, pages 25-26; Apr. 17, 1933, pages 27-28; April 24, 1933, pages 29-30; May 1, 1933, pages 35, 37; May 8, 1933, pages 32-33; May 15, 1933, pages 29-30; May 22, 1933, pages 32-33; May 29, 1933, pages 34, 37-38; June 5, 1933, pages 40, 42; June 12, 1933, pages 29-30; June 19, 1933, pages 31-32, 34; June 26, 1933, pages 39-40, 42; Vol. 93, July 3, 1933, pages 31-34; July 10, 1933, pages 32-33; July 17, 1933, pages 28-30; July 24, 1933; pages 29-30; July 31, 1933, pages 32, 34; Aug. 7, 1933, pages 30, 32; Aug. 14, 1933, pages 36-37, 39. Detailed discussion of the construction of open-hearth furnaces. Based on a study of the engineering, mechanical, structural, and operating details of 16 modern American stationary furnaces, rated nominally at 100 to 350 tons capacity per heat, with the majority about 150 tons capacity. Treated according to the principal components such as bottoms, back and front walls, roofs and their supports, lines, and ends. These are analyzed comparatively and capital and operating costs established. Temperature gradients and heat flow through refractories are treated graphically to clarify and simplify these problems as found in open-hearth furnace design. Suggests better methods that may be incorporated in an improved design. MS (6)

10

Principles of Electric Melting Furnaces (Grundlagen des elektrischen Schmelzofens) JOHANNES WOTSCHKE. Wilhelm Knapp, Halle, 1933. Paper, 6½ x 9½ inches, 505 pages. Price 42 RM. Vol. 52 of V. Engelhardt's Monographien über angewandte Elektrochemie. The design of large electric melting furnaces for steel and of smelting furnaces for ferro-alloys and carbide involves a very specialized type of electrical engineering. The mutual interaction of heavy currents in leads and electrodes complicate the calculations and many early furnaces had excessively low power factor and various electrical losses that are largely avoidable with proper engineering.

The special engineering problems of such furnaces are discussed in this book in considerable detail and with the use of much mathematics and many graphs. While some attention is paid to high and low frequency induction furnaces, direct arc furnaces are the main subject. Neither fused salt electrolysis nor resistor furnaces are considered. Details of transformer design, of regulating and metering equipment, and of electrode holders are not discussed, the treatment being confined to principles of construction and operation.

Much attention is given to the sources and magnitude of electrical and heat losses. Beside the information on design and construction of furnaces, there is much that has a bearing on economical operation.

Few books even touch on the electrical engineering problems dealt with in this and relatively few articles in periodical literature are of much help to the designer. Not many engineers are called upon to design large furnaces, but those who do will be very grateful for the comprehensive treatment of their problems in this book. H. W. Gillett (6)-**B-**

Proceedings, Conference on Electric Power Costs in the Foundry, 1933 Annual Convention. American Foundrymen's Association, Chicago, 1933. Paper, 8½x11 inches, 32 pages. Price $1.00. Serious allegations of utilities' unfair practices amaze the reader less than do the facts themselves, as tabulated and mapped by the Committee on Electric Power Costs in the Foundry (representing personnel of Steel Founders' Society, Gray Iron Institute and Malleable Iron Research Institute) whose report takes up the first half of this booklet. Facts are from specific answers in 129 returned questionnaires. Crazy-quilt of contract forms and special modifying clauses in 38 states and subdivisions is such that summary takes 6 pages. Power costs represent from 3.3% to 38% of selling price of castings—average for jobbing foundries between 20% and 30%. All but 4 establishments operating their own power plants failed to report 1932 Kwh costs; the 4 that did reported 0.60c, 0.50c, 1.94c and 1.16c. Purchased power rates, calculated on a uniform basis (load factor 20%, power factor 85%, prompt payment, all discounts except fuel clauses) averaged 1.9c per Kwh for 500 Kw and 1.65c per Kwh for 2000 Kw, but ranged all the way from 0.5c in one California plant to 2.48c in 2 Michigan locations and 2.75c paid by one unfortunate Texas plant. In many high-rate cases, of course, 50% or more of the total bill was represented by demand charges.

Committee finds utilities unfamiliar with problems of their industrial customers "nor have many of them shown much inclination to want to learn these problems. Too many utility rate structures are developed along the lines to get all the revenue that the traffic will bear and . . . customers cannot operate their own plants just as they should be operated without inflicting penalties on the operations that are very costly. In many instances rates and contracts have been made as complicated as possible so as to make it difficult to understand or compare rates of one locality with another." Report ends with recommendations covering Demand charges, Method of determining demand, Ratio of demand charge to annual charges, Off-peak and unlimited service, Minimum bill, Power factor clauses, Coal clauses, Term of contract, Parallel operations, Combination of service, Transformers, and Discounts. These recommendations bear evidence of painstaking formulation of general principles, but wording is unfelicitous in spots. Example, under Transformers: " . . . better practice for the customer to own . . . helps reduce utility company's capitalization; which results in lowering the demand charges in the rate . . ." It seems to the reviewer that "appraised property value" would have been preferable to "capitalization" because no public service commission nowadays allows rates to be based on capitalization.

Second half of booklet (stenographic transcript of discussions) reveals members' strong feeling and instances of just grounds therefor.

Though $1 for a 32-page pamphlet seems more excessive than 2.75c per industrial Kwh, this publication contains enough food for thought to warrant its being sent for by industrial power users within and outside of the foundry field—especially before they sign contracts they do not thoroughly understand. M.F.Béhar (6)-**B-**

Refractory and Furnace Trade Marks (Markenbezeichnungen im Feuerfest-Fach und im Ofenbau) Assembled by L. LITINSKY. Verlag L. Litinsky, Leipzig, 1934. Paper, 5¾x8½ inches, 98 pages. Price 6 R.M. The booklet is an alphabetically arranged list of approximately 1500 foreign and domestic trade names of refractories and furnaces with the name and address of the manufacturer.

In the appendix there is a list of books on furnaces and a subject index referring to the books. Richard Rimbach (6)-**B-**

Industrial Heat Transfer. ALFRED SCHACK. Translated by H. Goldschmidt & Everett Partridge. John Wiley & Sons, Inc., New York, 1933. Cloth, 6x9½ inches, 371 pages. Price $5.00. In spite of the recent appearance of other books in its field, this translation from the German edition of 1929 is heartily welcomed. The practical engineer interested in heat transfer in furnaces and heat exchanges will find it admirably suited to his needs. It is arranged in such a manner that reference can be made with a minimum of time and effort. The discussion is fundamentally sound and the derivation of the fundamental theory is unusually complete and comprehensible.

The treatment of radiation from flames is quite complete, but certain of the conclusions will bear further investigation. Heat transfer by convection is left in an unsatisfying form, but the fault lies in the subject rather than the author. Indeed, the author has struggled manfully with the complications of convection and surface conductance.

The translators have not taken their responsibility lightly. The spirit of the original is preserved in smooth English. The task of rendering all nomenclature, symbols, and units in accordance with American practice has been done with care and completeness. While resisting the temptation to re-write the book, they have introduced in notes the results of papers, mostly American, which have appeared since the original edition. The index has been greatly improved.

The translators are to be commended for making readily available in usable form the fundamentals of industrial heat transfer. H. W. Russell (6)-**B-**

Induction Furnaces for Heat Treatment and Preheating (Fours Electriques à Induction pour Traitement Thermique de Réchauffage) BOYER. *Arts-et-Métiers*, Vol. 85, Dec. 1932, pages 437-443. Principle of furnaces is first explained. Automatic temperature regulation is possible because magnetic character of material disappears at Curie point which varies in position as desired with composition of alloy used (Fe-Ni for low, Fe-Ni-Co for intermediate and Fe-Co for high temperatures). Advantages of induction furnace are then reviewed. FR (6)

Construction and Operation of a Coreless Vacuum-Induction Furnace (Bau und Betrieb eines kernlosen Vakuum-Induktionsofens) W. BOTTENBERG. *Archiv für das Eisenhüttenwesen*, Vol. 7, Oct. 1933, pages 233-236. A 25 kva induction furnace for melting and pouring 10 kg. melts in vacuo is described in detail. The furnace is enclosed in a steel vessel composed of two flanged and bolted water cooled hemicylinders. A vacuum of 0.08-0.1 mm. is obtained with the melt at 1500°-1600° C. The steel vessel is mounted on trunnions for tilting and pouring in vacuo. The melt can be observed through a glass window in the steel vessel. For good vacuum melting precautions should be taken to eliminate moisture. SE (6)

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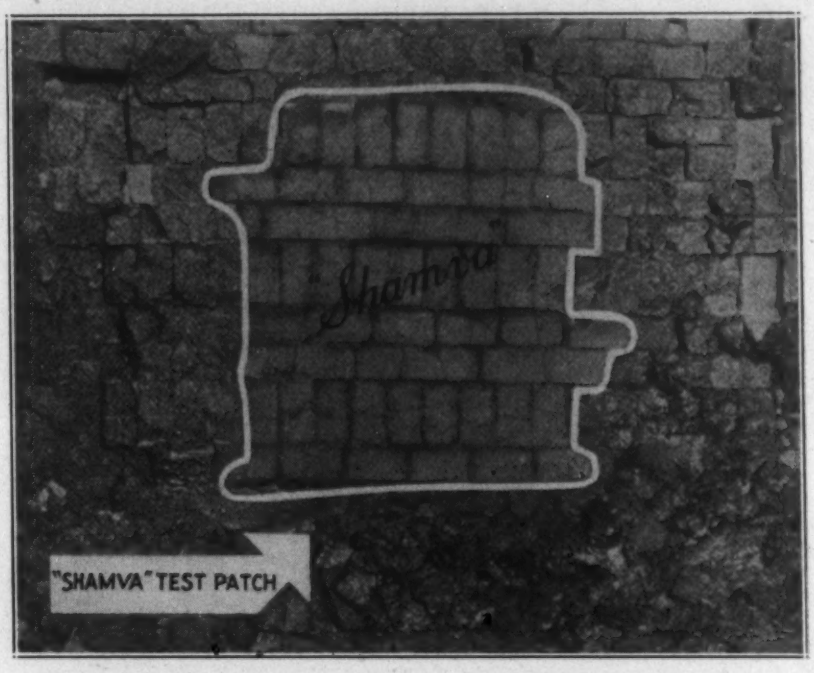

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Experiences with Graphite Electrodes in Steel Foundry (Erfahrungen mit Graphitelektroden im Stahlgiessereibetrieb) W. Behling. *Elektrowärme*, Vol. 3, July 15, 1933, pages 214-217. The question whether the amorphous or Soderberg, or the graphite electrode is the more economical in melting of steel has been quite generally decided in favor of the graphite electrode as it permits a shorter melting time and somewhat lower energy consumption as specific current consumption is lower. The amorphous electrode must often be preheated before operation, and does not stand as high a current density as graphite electrodes. A few examples of furnaces are given. Ha (6)

Influence of Charge of Coke Upon Value of Blast-Furnace Gas and on Operation of Metallurgical Plants (Influence de la mise au mille du coke sur la valeur du gaz de haut-fourneau et sur la marche des foyers à l'usine métallurgique) M. Gangler. *Revue Technique Luxembourgeoise*, Vol. 25, May-June 1933, pages 53-61. Experiments are described which show that the heating value of blast-furnace gases varies with the amount of coke charged into the furnace and also whether only ores or ore and scrap is charged. The results are laid down in tables; weight of gas freed increases with weight of coke charged, with temperature at which the furnace runs, and with the reduction in the furnace. The influence on the gas-consuming equipment and its economy is discussed. Ha (6)

Electric Resistance Furnaces for Continuous Operation. M. Hartenheim. *Fuels & Furnaces*, Vol. 11, Nov.-Dec. 1933, pages 211-214. Adaptability of electric resistance furnaces to continuous heat-treatment, especially of strip material is discussed in general. Some operating data are given. Ha (6)

New, Practical, Hoisting, Pre-Heating Furnace. J. M. Buchanan. *Industry & Welding*, Vol. 6, July 1933, pages 14-15. Furnace is built so that it can be placed over dismantled locomotive cylinders which are to be repaired by welding. Operating results and savings over other methods are given. Ha (6)

Electric Furnace with Controlled Atmosphere. R. F. Benzinger. *Heat Treating & Forging*, Vol. 19, Dec. 1933, pages 105-107. Availability of inexpensive non-oxidizing atmospheres, together with proper furnace equipment for their economical use, is materially changing many heating operations. Among gases developed are dissociated NH_3, Electrolene, developed by the General Electric Company, and Elfurno gas, a product containing H_2 and N_2 obtained by a process of the Electric Furnace Company. Latter can be produced at a cost of 15 to 25 cents per 1000 cu. ft. Continuous furnaces with protective atmospheres are used for bright annealing of non-ferrous metals; bright annealing or normalizing of a wide range of ferrous materials such as strip, wire, sheet, tubing, and rod; scale-free heat treating of many low-C steel parts which can be drop-quenched; and brazing of miscellaneous assemblies. Several installations are described briefly. MS (6)

Fuel Economy in an Iron and Steel Works in India. J. J. Ghandy & M. P. Kanga. *Journal Institute of Fuel*, Vol. 7, Oct. 1933, pages 37-40. Improvements in the blast furnace, open hearth and reheating furnace resulting in fuel economy are described. The cleaning of blast-furnace gas and the use of tar, coke-oven and blast-furnace gases are discussed. AHE (6)

Co-ordinated Heat Conservation at the Normanby Park Steel Works, Scunthorpe. W. J. Brooke. *Iron & Steel Institute*, Advance Copy, No. 4, Sept. 1933, 38 pages; *Iron & Coal Trades Review*, Vol. 126, Sept. 15, 1933, pages 375-379. Gives details of operation of furnaces and boilers at the steel plant. Data of works operation are given in several appendices. Ha + JLG (6)

Height of Cupola Furnaces. Jerzy Buzek. *Iron & Steel Industry & British Foundryman*, Vol. 6, July 1933, pages 338-339. Height of cupolas depend on volume, weight and surface area of pig Fe melted, weight of coke charged, and quantity of air entering cupolas. An empirical equation relates these factors. CHL (6)

Solving Problems in the Manufacture of Super-Refractory Insulating Shapes. E. J. Bognar. *Brick & Clay Record*, Vol. 83, Nov. 1933, pages 156-157. Problems encountered in the molding, drying, and burning of special shapes made from high aluminous super-refractory are discussed along with their solution. This refractory is replacing fire brick in many instances. The following are some examples: 1 core ovens, backing-up brick in electric furnaces, insulation of fan tails on open hearth, various parts of heat treating furnaces, doors of Al smelting furnaces, backing-up brick in crucible smelting furnaces, muffle doors of enamel and laboratory furnaces. Refractory acts as a refractory and an insulator. The general properties of the refractory include: (1) low coefficient of expansion, approximately 1/16" per linear ft. with max. expansion occurring between 1600 and 1900° F. (2) Can be used to 2600° F. under constant operation, in a clean atmosphere where fluxing ingredients are absorbent and no flame impingement occurs. (3) Fusion point of approximately cone 35 (3245° F.). (4) Modulus of rupture approximately 419 lbs./in.^{2} (5) Can be used where clean soaking heat exists. CBJ (6)

The Induction Furnace (Der Wirbelstromofen) K. Fischer. *Elektrowärme*, Vol. 3, Apr. 1933, pages 85-87. A few constructions of small furnaces for 2 melting, heaters of radiators and appliances are described. Ha (6)

Firing of Open Hearth Furnaces with Blast Furnace Gas and Wood-tar (Eldning av martinugn med masugnsgas och tjära) Arvid Johansson. *Jernkontorets Annaler*, Vol. 117, Mar. 1933, pages 123-143. Blast furnace gas from charcoal was found suitable for firing open-hearth furnaces provided the heating power is raised by the injection of wood-tar with preheated air to insure rapid combustion. The CO_2 content should be less than 10%. Gas from electric pig Fe furnaces is suitable during the smelting period, but during the firing period, injection of wood-tar is necessary to produce an incandescent flame. HCD (6)

Problem of Heat Recovery in the Design of a Blast Furnace (Il problemo del ricupero nel progetto di un forno a spinto per laminatoio) L. Bemporad. *La Metallurgia Italiana*, Vol. 25, May 1933, pages 315-338. Two types of 3 regenerative systems are considered, the baffle-plate type, of the Schack type, and the Siemens regenerators. The first is simpler and less expensive, but not as efficient. Local conditions must determine which is preferable. AWC (6)

Fuel Problems of Swedish Iron and Steel Industry. Arvid Johansson. *Iron & Coal Trades Review*, Vol. 127, July 7, 1933, page 10; *Foundry Trade Journal*, Vol. 49, July 13, 1933, page 26. Pig iron is produced in Sweden mainly with pinewood charcoal; lately electric pig iron furnaces have been installed as the charcoal supply diminishes. High quality steel is made only from charcoal pig iron. The production of iron sponge is greatly favored, the processes of Wiberg 4 and Ekelund by gas reduction and of Kalling by solid C being employed. The fuel for heating steel for rolling, forging and annealing is coal charged into producers connected to the furnace; electric furnaces are beginning to replace gas. Electric steel production in high-frequency furnaces is spreading. The particular conditions of Sweden with little natural fuel supply and its bearing on the steel industry is discussed. Ha (6)

Electric Furnace Lining (A propos du garnissage des fours électriques) Ch. Louis. *Journal du Four Electrique*, Vol. 42, Oct. 1933, pages 357-358. Good carbon lining can be made rapidly by making it of roughly shaped broken electrodes and filling the interstices with mixture of carbon and molasses. JDG (6)

Operation of a Crucible Furnace of 3 Tons Hourly Capacity (Etude concernant la Marche d'un Cubilot d'une Production horaire de 3 Tonnes) M. L. Gasquard. *Revue de Fonderie Moderne*, Vol. 27, Oct. 10, 1933, pages 267-272. Complete thermal balance sheet and composition of materials obtained and slags; the results seem to make the development of a special refractory lining advisable. Ha (6)

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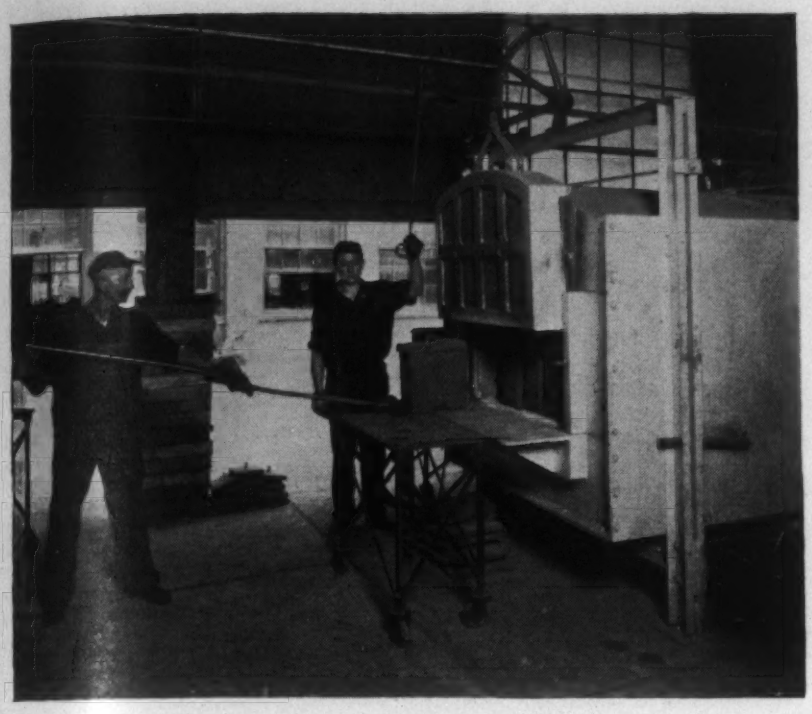

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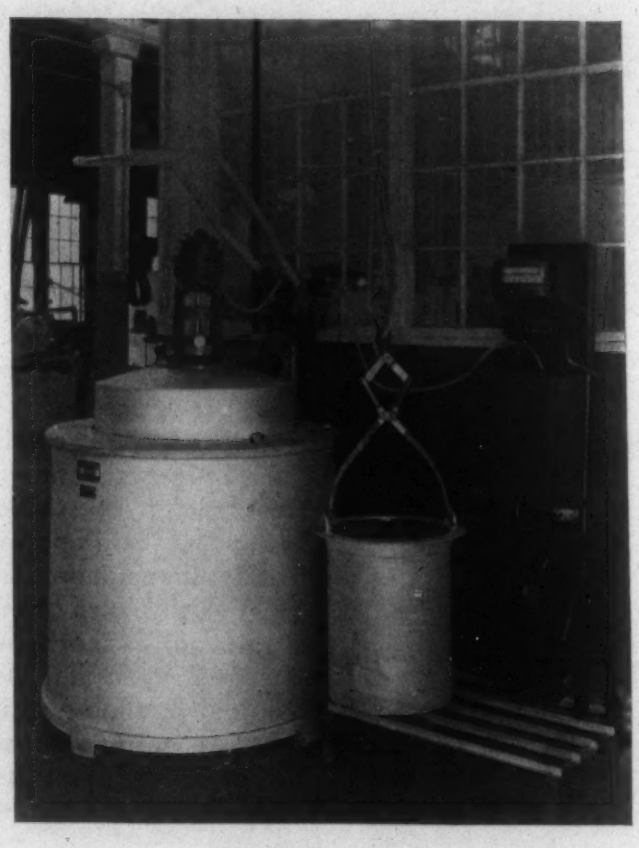

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JOINING OF METALS AND ALLOYS (7)

C. A. McCUNE, SECTION EDITOR

Soldering & Brazing (7a)

1 **Cost Cut on Motor Job by Electric Brazing.** A. FINKENSTEIN & M. W. BREWSTER. *Steel*, Vol. 92, Feb. 27, 1933, pages 21-23. In brazing 4 large sets of amortisseur windings on synchronous motors in the field, the electric resistance method effected a saving of 75% in time and 96% in cost of heat energy as compared with the oxyacetylene process. MS (7a)

Brazing of Stainless Steels (La Brasure des aciers inoxydables) A. BOUTTÉ. *Revue du Nickel*, Vol. 4, July 1933, pages 91-92. A brazing alloy containing Mn was recently developed. The composition is not given. It melts at 750° C. and its color is not much different from that of 18-8 steels. The mechanical and physical properties are excellent. It also obviates carbide precipitation in the regions where the brazing is done due to ease and rapidity of application. AH (7a)

2 **Simple Method of Brazing High-Speed Steel Tips to Low-Carbon Steel Shanks.** J. M. HIGHDUCHECK. *Machinery*, N. Y., Vol. 39, Mar. 1933, page 445. A compound of 12% borax, 20% of 50% ferro-silicon and 68% of 80% ferro-manganese. Add 25% by weight of clean high-speed steel filings, mix thoroughly. This compound is suitable for welding high-speed tips to shank material having the following composition range: C 0.50 to 0.63%, Mn 0.60 to 0.90%, P 0.04% max., and Si 0.15% min. Describes process, and gives temperatures for attaching tip to shank. RHP (7a)

Brazing of Cast Iron in Repairs of Machines (Gusseisenhartlötung bei Reparaturen von Maschinenbruch) H. v. OTHEGRAVEN. *Autogene Metallbearbeitung*, Vol. 26, Apr. 15, 1933, pages 117-120. On the basis of experiences over several years it can be stated that pieces can be soldered entirely satisfactorily if the fractured surfaces are pretreated, before soldering, with a flame with an excess of O and cleaned mechanically. If, however, the crack is not accessible, or if the surface has been smoothed down soldering with cast iron soldering powder gives better results. It is recommended not to machine the surface of the fracture as the liquid bronze solder finds its way readily into the crack. Ha (7a)

3

Brazing Drilling Bits with "Vokar" and "Pobedit" Alloys. V. S. FEDOROV & N. G. POSTARNAK. *Neftyanoe Khozyaistvo*, Vol. 24, No. 2, 1933, pages 109-112. In Russian. The "vokar" alloy is actually a mixture of W and C. In the brazing operation W_2C and small amounts of WC are formed. Steel high in C should be used on the sides of the bit to prepare a bed for the alloy. According to the Petroleum Research Institute of Grozneft the hardness of this alloy may be increased by 30% by the incorporation of up to 2% SiO_2. Graph permits determining the load on any part of the bit, thus permitting the proper distribution of the alloy. Pobedit is composed of 5.0-5.6% C, 80-83% W, 7.8-8.0% Co, 5-5.6% Fe and 1.8% Mo. It has a sp.gr. of 14.5, a m.p. of 2200°C., a hardness exceeding that of corundum and in its preparation a temperature not exceeding 1100°C. is used. The brazing operation is preferably carried out by electric welding. The performance of drills brazed with this alloy is illustrated in a table. AAB (7a)

4

Deoxidizers and Fluxes. G. L. BAILEY. *Metal Industry*, London, Vol. 43, Dec. 8, 1933, pages 561-564; Dec. 15, 1933, pages 583-587. The mechanism of soldering and the parts which deoxidizers and fluxes have to play in the process is explained at length. Oxide inclusions have a detrimental effect especially when they are soluble in the metal. The oxide formed by the deoxidizing reaction must be insoluble in the metal in order to be easily removed. P is a good deoxidizer for Cu and Cu alloys as it sublimes easily as P_2O_5 at comparatively low temperatures; it can also be used for Au and Ag. It prevents the formation of oxide skin on brasses and bronzes during pouring; quite small amounts, less than 0.05% suffice for the purpose. Fluxes should be solvents for metallic oxides, give inert covers to protect metal from oxidation and gas absorption; they should consist of materials for the removal of impurities other than O by either solution or reaction, or of volatile salts which remove inclusions by mechanical reactions, and they should be degasifiers. These various points are discussed and composition of fluxes for different materials described. 22 references. Ha (7a)

5

6

Welding & Cutting (7b)

Application of Gas Welding in Lignite Mining. (Anwendung der Gasschweissung im Braunkohlenbetrieb.) W. HOENISCH. *Die Schmelzschweissung*, Vol. 11, Oct. 1932, pages 209-211. See *Metals & Alloys*, Vol. 4, July 1933, page MA 218. Ha (7b)

Welding in the Decorative Arts. (Schweissen im Kunstgewerbe.) *Autogene Metallbearbeitung*, Vol. 26, May 1, 1933, pages 136-138. A number of examples of lamps, candle-holders, clock-housings, railings for stairways, etc., are illustrated. It is important that the welder keep the surface clean in his work in order not to destroy the artistic effect. Ha (7b)

7

Electric Arc Welding. (La Soudure Electrique a l'Arc.) R. SARAZIN. *Revue de Fonderie Moderne*, Vol. 26, Sept. 25, 1932, page 335. Advantages of employing arc welding with direct or alternating current for repairing in foundry are briefly described; amount of rejected material can be greatly reduced by it. Ha (7b)

A Reconditioned Gas Line in California Rebuilt with Welded Joints. WALLACE A. SAWDON. *American Gas Journal*, Vol. 138, Mar. 1933, pages 12-13. Weakened lengths of pipe were removed and replacements made with arc welded joints. CBJ (7b)

8

Welding in Machine Building. (Neuzeitliches Schweissen im Maschinenbau.) SCHAUBERT. *Die Elektroschweissung*, Vol. 4, Mar. 1933, pages 41-47. Compares riveting, casting and forging as contrasted to welding and discusses at length development of various structural elements used in welding. Welding finds increasing use for making rotating machinery parts, base plates, locomotive frames, grinding mills in the dye stuff industry, motor cases, etc. GN (7b)

Welding Aluminum and Alloys. J. R. SCHMIDGALL. *Journal American Welding Society*, Vol. 12, Apr. 1933, pages 22-24. Paper presented at Nov. 17, 1932, Meeting of Los Angeles Section, American Welding Society. The author gives instructions for preparation of joints, welding and finishing welds in aluminum sheet and castings. Both oxyacetylene and arc welding are discussed. TEJ (7b)

9

Welded Steel Pipe-Line of the Panther Valley Water Company. FARLEY GANNETT. *Journal American Welding Society*, Vol. 12, Feb. 1933, pages 11-12. Description of an arc welded water line, 10 miles long, 30½" in diameter. TEJ (7b)

The Design of Welded Structures. C. HESBEY. *Structural Engineer*, Vol. 20, Nov. 1932, pages 436-471; discussion, Dec. 1932, pages 520-529. Welded joint types most commonly met with in structural engineering are considered, including butt, cross fillet, longitudinal fillet, and diagonal fillet joint. Method of preparing V and X butt welds is taken up in great detail and following operation of eliminating distortion is advised. Each run of weld metal is left until it has become cold and then it is lightly hammered with a light, round-faced hammer. Best methods of fabricating stanchion bases and of reducing cross section of column and bracketing are given. Some of writer's practical ideas incorporated in an all-welded pier comprising 5 Warren trussed spans each 68 ft. long supported by trestles which rest upon groups of welded tubular piles cores of which were filled with reinforced concrete are considered. WH (7b)

10

FINISHING OF METALS AND ALLOYS (8)

H. S. RAWDON, SECTION EDITOR

Pickling (8a)

Some Causes of "Burning" or Overpickling of Steel. WALLACE G. IMHOFF. *Iron & Steel of Canada*, Vol. 16, Sept.-Oct. 1933, pages 101-104. Author summarizes these causes as (1) oil and grease in pickling bath, (2) storage of steel in damp place, (3) mixture of different metals in same pickling bath, (4) pits in articles to be pickled, occasioned by heavy scaling, (5) ignorance of proper pickling conditions, (6) inadequate control of pickling conditions, (7) lack of inhibitor, and (8) overcrowding of pickling baths. OWEp (8a)

Acid Dipping. MILTON MEEK. *Wire & Wire Products*, Vol. 8, Sept. 1933, pages 265, 282-283. The acids used in connection with the production of wire are discussed. HF is used only in extreme cases as when silica in the furnace tubes has attached itself to the wire. H_2SO_4 is used by about 90% of wire manufacturers. It is essential that the liquor be heated to insure efficient action; a 5% solution of H_2SO_4 at 70°-90° C. is the best mixture for wire cleaning. A 2% solution with higher temperature and longer immersion will make drawing much easier if time can be spared. H_2SO_4 converts the scale into ferrous sulphate. 1 part HCl 28°-32° Tw. to 2 parts H_2O is best for cleaning. The porous scale allows the liquid to reach the metal and the evolved H loosens and forces away the scale. HNO_3 is rarely used on account of its high cost; mixtures with H_2SO_4 or HCl have been used. The use of inhibitors to restrain the action of the acid on exposed metal is discussed. Their value is still questioned by some. The relative advantages of the different acid processes are discussed and methods of heating, agitating and recovering the acid described. Hap (8a)

Investigations on Chlorate Pickling Solutions (Untersuchungen über Chloratbeizen) H. KRAUSE. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 7, June-July 1933, pages 17-24; Aug.-Sept. 1933, pages 66-70. Metal-coloring baths containing as principal ingredient chlorate of potassium or sodium (not chloride) are reviewed and their compositions and chemical action on Cu, brasses, bronzes, Zn and Cd deposits discussed in detail. The addition of ammonium nitrate usually accelerates the action and gives deeper and brighter coloration. Ha (8a)

Investigation of Gray-Coloring of Copper Alloys by Pickling in Arsenic (Untersuchungen über Graufärbung von Kupferlegierungen durch Arsenikbeize) GEORG GROSS. *Oberflächentechnik*, Vol. 10, Dec. 5, 1933, pages 267-270. The gray-coloring of Cu alloys for instrument parts by immersion in a solution of 83 g. white As and 83 g. $FeSO_4$ in 1000 g. commercial HCl was investigated. It was found that the solution can be applied without having been first heated and cooled. The rate of coloring increases with temperature but 45° C. should not be exceeded for a steel-gray color. Chemically pure HCl can be used. Coloring is accelerated by repeated rinsing and drying of the ware; the gray tone is obtained more easily on mat surfaces than on polished. The pickling rate can be increased 50% by using 100 g. HCl, 21 g. $FeSO_4 \cdot 7\ H_2O$, 14 g. As_2O_3 at room temperature. A solution of 11.2 g. $FeSO_4 \cdot 7\ H_2O$ and 10.3 g. As_2O_3 in 100 g. HCl reduces coloring time from 25 min. to 10 sec.; it produces a gray tone on Zn sheet, brass, tombac, red brass, cast bronze, rolled bronze and Cu sheet. Ha (8a)

Cleaning, including Sand Blasting (8b)

Mechanism of Electrolytic Degreasing of Metals (Ueber den Mechanismus der elektrolytischen Entfettung von Metallen) B. KABANOW. *Kolloid Zeitschrift*, Vol. 65, Oct. 1933, pages 101-105. Degreasing of metallic surfaces is discussed as a polarization problem. The capacity of a surface to be moistened depends greatly on the polarization and influences electrolytic degreasing by the surface tensions acting on the border line solution | oil | gas. Additions to the electrolyte may hinder or accelerate the degreasing process. Ha (8b)

Preparation of Zinc and Zinc Alloy Surfaces for Coating. H. A. NELSON & W. W. KITTELBERGER. *Metal Industry*, London, Vol. 42, Feb. 1933, pages 147-149. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 362. Ha (8b)

Hidden Sources of Defects in Degreasing of Metals (Versteckte Fehlerquellen bei der Metallentfettung) R. JUSTH. *Oberflächentechnik*, Vol. 10, Dec. 5, 1933, pages 271-272. Unsatisfactory results in plating are often due to the degreasing applied immediately before plating. When degreased with P_3- solutions (trisodium phosphate) a slight passivation of the surface of the metal takes place which should be removed by rinsing of 1 min. in 5% HCl or 2-5% H_2SO_4 and subsequent rinsing in clean water. Brittle deposits might be due to electrolytic degreasing which had been carried out too long and at too high current densities; this is particularly the case for Ni-Cr plating. Electrolytic degreasing should be done for 1½ min. maximum at 6 to 8 V. maximum. In most degreasing processes it is advisable that the pieces are not dried after degreasing and be plated as soon as possible. An acid treatment of cold-deformed parts before plating is recommended to obtain an absolutely clean metallic surface on which the deposits adhere firmly. Treatment by various solutions is described. Ha (8b)

Polishing & Grinding (8c)

Selection and Handling of Felt Discs (Auswahl und Behandlung der Filzscheibe) H. HORSTMANN. *Oberflächentechnik*, Vol. 10, Nov. 7, 1933, pages 244-245. Preparation of polishing wheels of felt is discussed. Best circumferential speed for grinding is about 1700 m./min., and for polishing 2100 m./min. Soft metals, as brass, are polished best with iron oxide, polishing rod, emery, Viennese chalk; hard metals with chromium oxide, tin oxide, bone ash. Hap (8c)

Die Recutting, Polishing and Finishing. J. R. LONGWELL. *Wire & Wire Products*, Vol. 8, June 1933, pages 171, 185-186. Methods of finishing, polishing and recutting tungsten carbide dies and reclaiming materials used are discussed. Ha (8c)

Grinding Wheel with Binders of Artificial Resins (Schleifscheiben in Kunstharzbindung) H. HORSTMANN. *Oberflächentechnik*, Vol. 10, Apr. 18, 1933, pages 94-95. Brief description of a Bakelite grinding wheel which has the advantage that it can be made free of inner stresses thus reducing the danger of exploding, and further that the manufacturing time is shorter than for others. Ha (8c)

Obtaining Wear-Resistant Bearing Surfaces by Burnishing. A. T. KUEHNER. *Machinery*, N. Y., Vol. 39, July 1933, pages 713-715. Describes and illustrates processes and machines for burnishing. Refers especially to railway equipment. RHP (8c)

Dressing the Rolls (La rectification des cylindres de laminoires) EMIL LEVIN. *Aciérs Speciaux, Métaux et Alliages*, Vol. 8, Aug. 1933, pages 256-266. The use of Norton grinding wheels on finishing the rolls is discussed in detail. GTM (8c)

Mechanical Aids to Hot-Galvanizing. A. EYLES. *American Machinist*, Vol. 77, Dec. 6, 1933, page 781. Methods of proper galvanizing to insure protection against rust are discussed; chief requirements are that the coating is absolutely adherent, with no tendency to flake or peel, ductile and impervious to atmospheric moisture. Zn for hot-galvanizing should not contain more than 1.6% Pb and 0.08% Fe. Cd impairs the bright finish of the coating; Al and Sn in small quantities tend to give it a bright metallic finish; Sb makes it dull and brittle. The article to be coated should be completely immersed in the molten Zn surface until it is as hot as the Zn, otherwise an unnecessary amount of Zn will adhere. Ha (8c)

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Gear Tooth Finishing. FRED H. COLVIN. *American Machinist*, Vol. 77, June 7, 1933, pages 357-359. The best practice of gear cutting and finishing is discussed; the 2 processes should never be combined, irregularities of cutting should be removed during finishing by running-in, lapping or grinding with an abrasive. A few modern machines are described. Ha (8c)

Gear Lapping after Heat-Treatment. R. S. DRUMMOND. *American Machinist*, Vol. 77, May 24, 1933, pages 331-333. Lapping as a corrective operation for gears after heat-treatment, is discussed. Noiselessness of gears requires high accuracy in dimensions which are sometimes impaired in heat-treatment after cutting. Recent methods and developments of lapping are discussed. Ha (8c)

Sharp Tool Wheels Make Sharp and Accurate Tools. L. K. BEHR. *Grits and Grinds*, Vol. 25, Sept.-Oct. 1933, pages 1-11. Grinding wheels and methods for tools, gears, rolls, etc., of different materials are discussed. Ha (8c)

Grinding of Cylinders with Colloidal Graphite (Zylinderschleifen und Kolloidgraphit) ERICH KADMER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, Oct. 22, 1933, page 592. Discusses use of colloidal graphite in fine drilling, honing and lapping of automobile cylinders. Lubricating capacity of colloidal graphite is a function of its degree of dispersion. GN (8c)

Initial Wear. R. E. W. HARRISON. *Product Engineering*, Vol. 4, Dec. 1933, pages 452-453. The wear during the running-in period depends on the surface finish. With finest finishing processes possible today, initial wear can be limited to 0.0001". Cr plating adds materially to the life of bearing surfaces. Tool performances and conditions of finish are discussed. Ha (8c)

Instructions for Finishing Welded Plates of Monel Metal and Pure Nickel. W. F. BURCHFIELD. *Welding Engineer*, Vol. 18, July 1933, pages 24-26. Means of finishing by grinding and polishing of Monel and Ni plates to give any desired surface effect from sand blast to a highly lustrous finish are described. Selection of buffing and polishing wheels, preparation of the latter, size of abrasive and glue to be applied and finishing light-gage sheets are discussed. Ha (8c)

Highest Grade Finishing (Feinstbearbeitung) KARPINSKI. *Oberflächentechnik*, Vol. 10, Apr. 4, 1933, pages 79-83. Production of high-quality finish, either for decoration by polishing without requirements of accuracy, or for very accurate dimensions by lapping, honing, grinding, press-polishing is described in detail together with the instruments and tools used. Ha (8c)

Polishing Powders. A. JONES. *Sands, Clays & Minerals*, Vol. 1, July 1933, pages 47-50. Naturally occurring earths and clays and their application as polishing materials are described; most used are clays, chalks and whiting, rotten stone (a weathered lime stone), French chalk, kieselguhr, tripoli, rouges (ferric oxides), pumice powders, carborundum (not natural), Vienna lime and oxide of Cr. Ha (8c)

Grinding Operations in Locomotive Repair. FRED B. JACOBS. *American Machinist*, Vol. 77, Apr. 12, 1933, pages 233-235. Detailed description of grinding methods and tools and auxiliary devices. Ha (8c)

Lapping All Teeth of Gears Simultaneously. CHARLES O. HERB. *Machinery*, N. Y., Vol. 39, July 1933, pages 689-692. Describes and illustrates machinery and methods used. This process gives uniformity and permits the interchanging of gears. RHP (8c)

Premature Cylinder Wear (Zum Thema vorschnelle Zylinderabnutzung) A. MAISCH. *Deutsche Motorzeitschrift*, Vol. 10, Jan. 1933, page 14. Microscopic investigation of honed cylinder walls revealed minute metal particles only loosely connected with the wall. With high compression piston rings, they are torn off and act as an abrasive. The trouble was overcome by applying a metal brush for 2 min. after finish machining. Though less smooth in appearance, the brushed surface does not fail prematurely by excessive wear. Honing should take off 0.1-0.15 mm. instead of only 0.01 mm. as widely exercised. Dry grinding is preferable to wet grinding since the grinding slime can be removed only with great difficulty from the metal "pores." EF (8c)

Electroplating (8d)

Adjustment of Silver Baths (Die Richtigstellung von Silberbädern) K. Bihlmaier. *Mitteilungen des Forschungsinstitut und Probieramts für Edelmetalle*, Vol. 7, May-June 1933, pages 24-28. The concentration of electrolytes for Ag plating should be checked continually during operation; this is more economical than to wait until the deposit becomes defective. The adjustment should include Ag content, free cyanide of potassium and potassium carbonate (potash). Ag content is usually 10 g./l. for heavy deposits and 30-40 g./l. for rapid Ag plating solutions. The bath is less sensitive to changes in Ag than to changes in the ratio of Ag to free cyanide of potassium which latter should not be more than 50% of the Ag in new and about 100% in rapid plating baths. Several examples show how to calculate the quantities of the ingredients to be added to keep the solution in proper condition. Hap (8d)

Nickel Plating of Brass (Nickelage électrolytique du Laiton) A. W. Hothersall. *L'Usine*, Vol. 42, June 30, 1933, pages 27-29. The peeling of Ni deposits under later treatment, as polishing, and particularly when put in the bath for Cr plating was investigated. The principal effort must be directed towards preparation of scrupulously clean surface for the Ni deposit. Buffing, chalking, anodic treatment, heating to 250° C., are employed with more or less success. The best cleaning methods known at present for good adherence of Ni consist in immersing the properly degreased metal in a solution of 30% (volumetric), or more, of HNO_3 or in a mixture of 530 cc. H_2SO_4, 160 cc. HNO_3, 0.75 cc. HCl and 320 cc. H_2O; it should be kept in the solution until it is visibly attacked. More recent methods are a solution of 5% KCN or one of 50 g. citric acid in H_2O neutralized with ammonia to which is added 20 g. citric acid dissolved in water. This is diluted 1:1 before using. The last 2 solutions do not produce the reddish tint common with acid treatment. Hap (8d)

Surface Hardening by Chromium Plating (Oberflächenhärtung durch Verchromung) K. Altmannsberger. *Oberflächentechnik*, Vol. 10, Feb. 21, 1933, pages 41-42. The mechanism of surface hardening by Cr plating is discussed. The physical character of the deposited Cr, especially its hardness is principally influenced by the H which is absorbed during electrodeposition; Ni absorbs 11 times, Fe 110 times and Cr 250 to 450 times its volume. The H absorption depends on the current density. Maximum hardness is obtained at 62 amp./dm.^{2} and is then 43 times as great as at normal density of 16 amp./dm.^{2} It is assumed that the H atoms diffuse through the cubic crystal lattice of the Cr and thereby cause a strong deformation of the lattice which results in the increase in hardness. Thermal treatment can relieve the lattice strain and thus the hardening effect. The practice of obtaining good Cr deposits is described; the most favorable thickness is between 0.8 and 5 μ. Current density should be such that a layer of about 2.5 μ is deposited in 1 hr. The resistance to wear of Cr plated tools can be improved by thermal treatment consisting mostly in heating to 230° C. for ½ hr. The formation of an alloy of the base metal and the Cr deposit must be absolutely avoided as this would change the crystal structure to which the hardness is due. Practical applications of Cr plated rolls, cylinders and other equipment in printing are described and suggestions made for detecting causes of failures of Cr deposits. Hap (8d)

Chromium Plating for Automobile Service (Die Verchromung unter besonderer Berücksichtigung ihrer Anwendung im Automobilbau) E. H. O. Bauer, H. Arndt & W. Krause. M. Krayn Technischer Verlag, Berlin, 1934. Paper 6¾ x 9½ inches, 256 pages. Price 22 RM. A very comprehensive study of the behavior of Cr plating on 65 different lots of specimens, some of which were taken from French and American automobiles, the rest of which were prepared in the laboratory. The thickness of the Cr coat and of all the under-layers was determined for each specimen. Study was made of cracking and peeling under deformation, of abrasion resistance, porosity, and of corrosion resistance.

Some attention was paid to platings on cast red brass, on cast aluminum alloys and on zinc die castings. The last two are not recommended by the authors for exterior use on autos. The most extensive comparison was made of steel and brass as bases for plating upon. Steel is preferred only for cases where rather high temperature service is involved; for all exterior use on the car and for interior use where moisture can be present, brass is preferred. The photographs of the corrosion and exposure tests, some of which are horrible examples of what not to do, bear out this conclusion.

While successive layers of Ni, Cu, Ni, Cr gave best results as to freedom from porosity, most of the materials studied were Ni, Cr on brass or Cu, Ni Cr on steel. The value of a thick Ni under-layer is clearly brought out and a thickness of over 15 μ is recommended. The Cr coat itself appears to be best at 0.5 μ, thinner coats being deficient in freedom from porosity and thicker ones too prone to crack.

Oiling of Cr plated auto parts is recommended.

The experiments are recorded in considerable detail and are of interest not only for their results and the conclusion to be drawn therefrom but also from the point of view of methods of testing. H. W. Gillett (8d)-B-

A Study of Cyanide Zinc Plating Baths Using the Aluminum-Mercury-Zinc Anode. A. Kenneth Graham. *Transactions Electrochemical Society*, Vol. 63, May 1933, pages 121-133. The performance of the Zn anode containing 0.5% Al and 0.3% Hg was studied in 1N $Zn(CN)_2$ baths at 20 amp./ft.^{2} (2.2 amp./dm.^{2}) and 120° F. (49° C.). The NaCN was varied from 0.5 to 1.5 N. and the NaOH from 0 to 1.9 N. The current efficiencies, anode polarization, bath voltage, solution maintenance and sludge formation were observed. A bath in which the normal ratio of NaCN + NaOH to $Zn(CN)_2$ is 2 or higher, and containing between 5 and 8.5 oz./gal. (37.5 and 63.7 g./l.) of NaCN and between 4.5 and 10 oz./gal. (33.8 and 75 g./l.) of NaOH appears superior to baths recommended by Wernlund (1921) and by Blum (1921). Na_2CO_3 seems to have no effect upon the characteristics of the 1N $Zn(CN)_2$ bath. Pure Zn anodes show higher anode efficiency than the Zn alloy anodes, both being over 100%; otherwise they behave alike. LCP (8d)

Complex Cyanides in Brass Plating Baths. L. C. Pan. *Transactions Electrochemical Society*, Vol. 62, Sept. 1932, pages 63-75; *Quarterly Review, American Electroplaters Society*, Vol. 19, July 1933, pages 33-38. In literature on cyanide solutions containing both Cu and Zn, the complex cyanides have been generally represented by $Na_2Cu(CN)_3$ and $Na_2Zn(CN)_4$. In making up brass electroplating solutions using these formulas as basis, there was found always an excess of free cyanide over the calculated amount. By analyzing series of brass plating solutions with various amounts of Cu, Zn and Na cyanide and by four different methods of volumetric analysis, the author proved that the complex compounds in such solutions are $Na_2Cu(CN)_3$ and $NaZn(CN)_3$ and not $Na_2Zn(CN)_4$. The proof is also given graphically in three sets of curves. LCP (8d)

The Decomposition of Cyanide Solutions. R. M. Wick. *Quarterly Review, American Electroplaters' Society*, Vol. 19, Apr. 1933, pages 20-23.

Cyanides in aqueous solutions decompose according to the following reactions:

$$1.\ \left.\begin{matrix}KCN + H_2O \rightleftarrows KOH + HCN\\ KOH + CO_2 \rightleftarrows K_2CO_3 + H_2O\end{matrix}\right\}$$

$$2.\ KCN + 2H_2O \rightarrow HCOOK + NH_3$$

At 25° C., 0.5 N. KCN is 70% decomposed in 10 days in an open vessel. At 45° C. the rate of decomposition is increased and at 65° C. the second reaction predominates. Adding hydroxide to a cyanide solution may retard its decomposition. LCP (8d)

Metallic Coatings other than Electroplating (8e)

Cathode Sputtering—A Commercial Application. Hal F. Fruth. *Metal Industry*, N. Y., Vol. 30, Nov. 1932, pages 428-431. Sputtering is the process of electrostatic deposition of metals by high voltages in a partial vacuum. This process can be used (a) to deposit metals upon non-conductors, (b) to metallize surface which would be injured by contact with chemical solutions or high temperatures, (c) to produce a very thin continuous metal coat or a very smooth highly reflecting coat, (d) to deposit metals such as Si, Te or Se, that are very difficult to deposit in any other way, (e) to deposit one metal upon another far removed from it in the electromotive series, such as Au or Pt upon Al or Mg. The commercial application of sputtering process is illustrated by describing a Au surface applied to a duralumin diaphragm for carbon broadcasting transmitters. PRK (8e)

Dross in Metal Ware Galvanizing; Quantities and Percentages. Wallace G. Imhoff. *Metal Industry*, London, Vol. 43, Oct. 13, 1933, pages 364-370; Oct. 27, 1933, pages 419-421. The cause of dross formation was investigated; figures over a number of years for coal, coke, gas or oil as fuel for heating the Zn bath showed practically no difference in the amount of dross; it averaged from 8 to 12%, with a maximum of 26% and a minimum of 7%. In addition to dross from Fe from the pot, large quantities of dross result from the salts carried over with the pickling solutions on the goods into the pot, from corrosion products of the materials formed while standing in the air before going into the pot, and from careless temperature control of the bath. Fuel has practically no influence, other causes should be eliminated. Ha (8e)

Metal Spraying. W. E. Ballard. *Metal Industry*, London, Vol. 43, Nov. 24, 1933, pages 509-512; Dec. 1, 1933, pages 535-537. The various methods for spraying metals are described; the wire pistol gives very homogeneous mixtures of metals, if a wire coated with another metal be used in the pistol an intimate mixture, not an alloy, is formed. Procedures for spraying Al, Pb, Zn and Sn are discussed, metal losses, their prevention and recovery described and illustrated by examples. Ha (8e)

On Deposits of Metallic Mercury by High-frequence Discharge. D. Banerji & Radharaman Ganguli. *London, Edinburgh, & Dublin Philosophical Magazine & Journal of Science*, Ser. 7, Vol. 15, Mar. 1933, pages 676-681. Rings, which are due to a deposit of Hg, form under certain conditions on the inside wall of a high-frequency discharge-tube containing Hg vapor. Illustrated by photographs showing shape and position of rings. RHP (8e)

Cementation of Zn into Some Metals by Means of Zinc Dust. (I). T. Kasé. *Kinzoku no Kenkyu*, Vol. 10, Dec. 1933, pages 555 to 572. In Japanese. Cementation of metals and alloys-Fe, Cu, brass, Ni, etc.—by means of Zn-dust at various temperatures between 250-800° C. was investigated. Hardness, depth of penetration, microstructure, chemical analysis, and corrosion by water or some acids were studied for the cemented surface layer. Following facts were established: Diffusion of Zn into the metals listed starts at 150°, and increases with increasing temperature. The relation between the weight increase of the specimen, or the depth of penetration, and the temperature of cementation can be expressed by an exponential equation, which breaks into two branches at the m.p. of Zn. Relation between the weight increase of the specimen and duration of cementation can be expressed similarly. When it is exposed to air or water the cemented surface resists corrosion better than the base material. KT (8e)

Non-Metallic Coatings (8f)

Experiments and Success of the German State Railways in Protection Against Corrosion by Painting (Arbeiten und Erfolge der Deutschen Reichsbahn auf dem Gebiete des Korrosionsschutzes durch Anstriche) O. Lindemayer. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Apr. 15, 1933, pages 385-392. Experience of the German State Railways in protecting steel structures against corrosion by painting is described in detail. Preparation of the surface is important, yet it was found that there need not always be an absolutely rust-free surface before applying the coat; some natural oxide films or scale may well be left on as they themselves form a rust prevention and improve the adherence of the coat. Cu steel with 0.2 to 0.25% Cu possesses great resistance to rusting, holds the coat well and prevents penetration of rust by the formation of an adherent oxide coat. Various varnishes, paints, and other non-metallic coatings are discussed from viewpoint of economy in service. Great progress has been made in the application of chlorinated caoutchouc which is used in thin layers (1 mm.) on door handles, railings, etc. of railroad cars. Preparation and application of this material are described. It is emphasized that no protective means can be effective unless the designer from the beginning avoids all constructional features which favor corrosion; good accessibility, freedom from crevices where water can collect, etc., are important. 14 references. Hap (8f)

Protection of Metallic Surfaces. Parkerizing and Bonderizing (La Protezione delle Superficie Metalliche. Parkerizzazione e Bonderizzazione) O. Macchia. *L'Industria Meccanica*, Vol. 15, Feb. 1933, pages 101-107. The processes of parkerizing and bonderizing of steel are described and the character of the obtained surface protection explained. 38 references. Ha (8f)

Quick-Drying and Enduring Finishes. H. Chase. *American Machinist*, Vol. 77, Apr. 12, 1933, page 241. General discussion of durability, weather resistance and composition of synthetic, quick-drying paints. Paints made with rezyl gums do not require polishing; particularly suitable for sheet metal. Ha (8f)

New Ways of Producing Highly Resistant Coatings on the Basis of Phenol Resins (Neue Wege zur Erzielung hochwiderstandsfähiger Überzüge auf Basis reiner Phenolharze) J. Harlass. *Farbenzeitung*, Vol. 38, Oct. 7, 1933, pages 1466-1467. Report of tests with Super-Beckacite 1001, a coating having great resistance at elevated temperatures and to chemical reagents. It has remarkable hardness, and elasticity and excellent adhesion on Fe, Zn and Al. The coating is applied by brush or pistol spraying on the metal surface, freed from grease and rust, and heated to 190°-200° C. for 1-4 hours. The metal can be severely deformed with a hammer without loosening the coating. EF (8f)

Adhesive Strength of Protective Coats (Haftfestigkeit von Schutzanstrichen) P. Nettmann. *Oberflächentechnik*, Vol. 10, July 4, 1933, page 158. Molecular structure, formation of crystalline nuclei, influence of drying agents upon the adhesion of paints are discussed. No adequate testing method has as yet been developed for measuring adhesion. A few methods with apparatus are briefly described. Ha (8f)

X-rays for the Study of Porcelain Enamels. W. N. Noble. *Better Enameling*, Vol. 4, Aug. 1933, pages 18-20. Fundamentals of X-ray generation and application in crystallographic analysis are discussed. In ceramics x-rays are used for: 1. Chemical identification of crystalline compounds; 2, grain size determination; 3, determining whether material is crystalline or non-crystalline; 4, determination of the crystalline form of the material; 5, classification of the crystalline structure as random or fibered; 6, detection of internal strain. CBJ (8f)

Oxide Coatings on Aluminum. J. D. Edwards, M. Tosterud & H. K. Work. *Transactions American Institute of Electrical Engineers*, Vol. 51, Dec. 1932, pages 900-902. See *Metals & Alloys*, Vol. 4, Mar. 1933, page MA 68 and July 1933, page MA 209. Ha (8f)

Coloring of Brass (La Coloritura del Rame) O. Macchia, D. Raffaelli & E. Bernabei. *L'Industria Meccanica*, Vol. 15, Mar. 1933, pages 222-224. Discussion of modern methods of coloring brass, especially production of artificial patina, with particular reference to industrial and domestic application. Ha (8f)

TESTING OF METALS AND ALLOYS (9)

Inspection & Defects, including X-Ray Inspection (9a)

C. S. BARRETT, SECTION EDITOR

X-rays in Metal Investigations. G. V. KURDJUMOV. *Domez*, No. 5-6, 1933, pages 34-44 (In Russian). Survey of methods in use and results achieved by the use of X-rays in metallurgy. 53 references. p (9a)

Causes of Failures of Cast Iron Boilers (Über die Ursache der Brüche gusseiserner Kessel) M. V. MAUBRAS. *Gesundheitsingenieur*, Vol. 56, Feb. 18, 1933, pages 82-83. Cause of fractures mostly noticed on hot water boilers is mainly ascribed to growing of cast iron. This phenomenon dealt with at length is remedied by additions of Ni or Cr in case of low Si contents. Another source of trouble is the occurrence of incrustations, leading to local overheating and failure. WHp (9a)

Defective Rails. H. H. MUNRO. *The Railway Engineer*, Sept. 1933, pages 259-260. Editorial Comment, pages 258-259. Munro reports on results gained with the Sperry detector car sent over to inspect French railroad tracks. The C content of continental rails is usually lower than in this country. In spite of the low average of 0.45% C, one defective rail for every 3 km. tested has been found on 4,000 km. of track inspected so far. Of the defective rails, 20% were rails containing transverse or compound fissures. Another unexpected result was the large number of rails containing more than one defect in the same rail. A photo of 55 fractures is shown taken from a rail which contained 55 separate invisible transverse fissures. Referring to heat-treated rails, the writer states, "it is significant that not a single defect in a heat-treated rail has been found so far." This evidently refers to the Sandberg oven process, which represents a retarded cooling process. The editorial comment urges information relating the frequency of actual failure to frequency of occurrence of each type of defect as some types may outlast the life of the rail. The most frequent cause of rail failure in Great Britain is secondary piping, which is a longitudinal fissure usually in the lower part of the rail head. It is due to the fissure condition of the ingot. WHp (9a)

X-Ray Diagnosis in Welding Technique (Röntgendiagnose in der Schweisstechnik) H. KOCHENDOERFER. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen*, Series 8, 1933, pages 76-81; *Autogene Metallbearbeitung*, Vol. 26, Aug. 1, 1933, pages 230-235. X-ray testing methods have proved their great value particularly in the examination of welding wire, for its quality can be determined with certainty from the X-ray picture of the weld; further in the continuous checking of the welders, and in the supervision of continuous production of welded seams by random sampling; the latter can be assisted by a so-called "defect-detector." Photographs illustrate various forms of seams and different kinds of defects in their characteristic appearances on the photographic plate. Hap (9a)

Radiograph of the Weld (Röntgenbild der Schweissnaht) H. HALBERSTADT. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen*, Series 8, 1933, pages 71-76; *Autogene Metallbearbeitung*, Vol. 26, Aug. 1, 1933, pages 225-230. Modern portable X-ray apparatus is described and technique is explained. A weld shows usually the following characteristic radiograph: gas holes appear as circular or elliptical spots of uniform blackening, slag inclusions strongly blackened as compared with the basic material with the difference that the borders are entirely irregular. Fine cracks and defective joints appear also somewhat blacker, and embedded foreign material of a higher atomic number is lighter than the other parts. The topographical location of defects in 2 and 3 dimensions is explained. 4 references. Hap (9a)

Material Testing with X-Rays (Materialprüfung mit Röntgenstrahlen) F. BRANDENBURGER. *Schweizerische Bauzeitung*, Vol. 102, July 22, 1933, pages 39-42. Discusses the possibilities of testing materials by X-rays, either for determining crystal structures or detecting defects, as inclusions, cavities, cracks, segregations, etc. The field of application is outlined. GNp (9a)

The X-Ray Inspection of Aluminium Alloy Welds. N. C. HYPHER. *Metallurgia*, Vol. 8, Sept. 1933, pages 145-146, 148. Discusses different types of welds and shows radiographs of several welds. The author considers shrinkage cracks and oxide particles in welds difficult to detect by X-ray methods. JLGp (9a)

The Burden of Defective Rails. CECIL J. ALLEN. *The Railway Engineer*, Nov. 1933, pages 337-340. Author urges (1) "pooling" of information regarding defective rails, (2) special marking of top rails from ingots in which the vast majority of piping and associated defects are found. Statistics of fractured rails (1931) disclosed by 12 different continental railroad companies are presented. According to this detailed investigation, the rail manufacturer would be responsible, by the defects in their products, for the incidence of at least two-thirds of the defects tabulated. WHp (9a)

Some Causes of Breakage of Haulage Appliances. J. H. ANDREW & H. M. HUDSPETH. *Iron & Coal Trades Review*, Vol. 128. Jan. 5, 1934, pages 8-9. Investigation of predominant causes of failure from the metallurgical point of view show that they are mostly associated with composite material and inclusions, welding and surface hardening by abrasion. Elimination of defects is desirable not so much by better testing methods but rather by using more reliable and homogeneous materials. Hap (9a)

Industrial Radiography. ANCEL ST. JOHN & H. R. ISENBURGER. John Wiley & Sons, Inc., New York. 1934. Cloth, 6 x 9¼ inches, 232 pages. Price $3.50. While the general discussion includes radiography of such things as paintings, standing trees, etc., etc., the bulk of the book relates to examination of metallic objects for hidden defects. The book is confined to radiography by X-rays or gamma rays, and does not include discussion of atomic structure. Medical radiography is not dealt with.

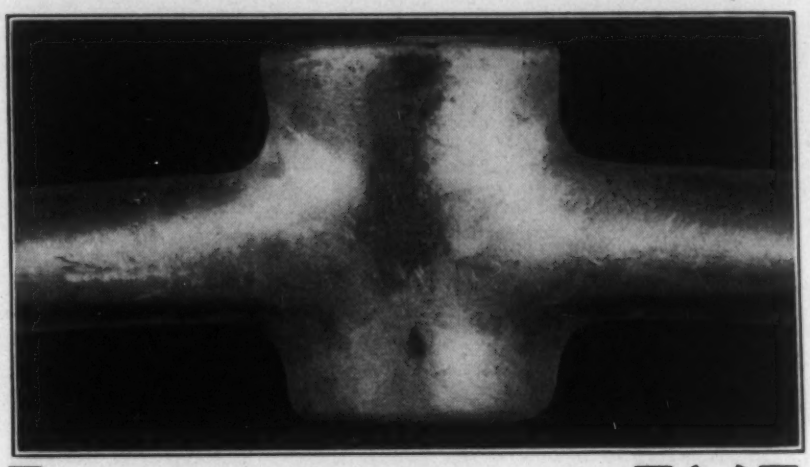
The principles involved, the equipment used, and the procedure required are briefly discussed. Methods of exposing the object from two or more angles so as to locate the defects shown up, in more than one plane, are discussed, with illustrations of practical examples. Especial attention is given to castings and to welds.

The writers say, "Only those who have seen X-ray proof really know that a casting is sound. All others are trusting to belief." They allege that radiography is cheaper than cutting up castings when the proper method of gating to produce a perfect casting is being sought.

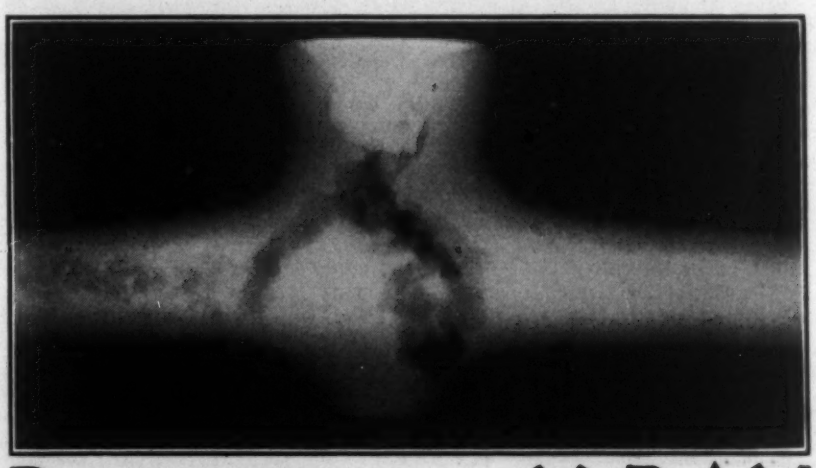
The book will be helpful to operators of radiographic equipment and of interest to those who are considering having their products radiographed for research or inspection purposes. H. W. Gillett (9a)-B-

Surface Defects in Rolling (Oberflächenfehler auf Walzgut) H. CRÄMER. *Stahl und Eisen*, Vol. 53, Sept. 21, 1933, pages 973-984. Various surface defects in rolled steel are described and their causes discussed. It is frequently difficult to determine whether a defect is due to poor steel or poor rolling. In discussion it was stated that a way to help settle such questions is to set aside an ingot before it is rolled and examine the structure at and near the surface, in the unrolled state. SE (9a)

Numerical Values as a Measure of Quality in Materials Testing and Specifications (Die Zahl als Gütemassstab bei der Werkstoffprüfung und-abnahme) A. FRY. *Stahl und Eisen*, Vol. 53, Aug. 31, 1933, pages 901-904. While numerical values in specifications are of the greatest aid it should not be forgotten that they do not always express the real requirements, but must be sensibly interpreted. Thoughtless, mechanical use of the test data can lead to false conclusions. SE (9a)



FLAWLESS says the EYE



PLUGGED says the X-RAY

CHECK says the SAW

—that's the story of an aluminum casting that had been causing no end of trouble and expense in the machine shop. But not the whole story, for *non-destructive* x-ray inspection soon enabled the foundry to correct not only the cause of these blowholes, but other defects due to inclusion of dross, dendrites, etc.

This is but one of the many "case histories" that make the new edition of the G-E booklet *Industrial Application of the X-Ray* well worth reading, whether you cast, forge, roll, draw, weld, machine, assemble or analyze metallic products. It is yours for the asking.

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Conventional Gages and Their Application to Duplicate Production. THOS. F. MCLAREN. *Transactions American Society of Mechanical Engineers*, Vol. 54, June 30, 1932, Machine Shop Practice, pages 67-71. A general survey of important points for standardization of gaging methods. Ha (9a)

Note on the Suitability and Utility of the Impact Test for Inspection of Welds. (Note sur la convenance et la commodite de l'essai de resilience pour la reception des soudures.) H. DUSTIN & D. ROSENTHAL. *International Association for Testing Materials, Zurich Meeting, 1931*, Vol. 1, 1932, pages 409-411. Some of the usual questions as to size and form of specimens are discussed with special reference to welds. Impact is desirable inspection test for welds. HWG (9a)

Pin Inspection of Tooth Profiles. S. TRIMBATH. *American Machinist*, Vol. 76, May 26, 1932, pages 673-674. Method of testing gears for eccentricity and checking tooth form by pins is described and illustrated. Ha (9a)

Measurement of Surface Roughness. (Messen der Oberflächenrauhigkeit.) G. SCHMALTZ. *Maschinenbau*, Vol. 11, July 7, 1932, page 279. See *Metals & Alloys*, Vol. 4, May 1933, page MA 158. RFV (9a)

Inspecting Device for Gas Containers. (Prüfgerät für Gas Flaschen.) G. LOECK. *Zeitschrift Verein Deutscher Ingenieure*, Vol. 76, Aug. 13, 1932, page 804. Optical instrument of 20 mm. diameter and 2000 mm. length for the inspection of containers for compressed gases. Ha (9a)

Inspection of Surfaces for Minute Defects. F. A. FIRESTONE & H. B. VINCENT. *Mechanical Engineering*, Vol. 54, Sept. 1932, page 648. An automatic machine was developed by Engineering Research Department of University of Michigan for closest examination of surfaces; it consists mainly of an electric eye, a photocell, which produces an electric current proportional to illumination it receives from test piece. Current can be used for an automatic rejection or passing on of piece. Ha (9a)

Gage for File Test. BERTOLD BUXBAUM. *Metal Progress*, Vol. 23, June 1933, page 48. A file testing gage of a series of balls or rings is hard to produce uniformly. A handy device has been patented by the author consisting of a ⅜ in. round bar of C tool steel, 4 in. long, mounted in a wooden handle. A flat surface is ground along the length about ¼ in. wide. The bar is hardened to Rockwell C-66 at one end, changing gradually to C-57 at the other end. Hardness numbers are etched on the flat surface. For testing, the gage is "touched" with the file at the desired hardness number, then the tool to be tested is "touched." Resistance to touch should be the same. If not, the file should be tried along the gage till the corresponding hardness is found. Surfaces on the test piece and gage should be of the same nature—flat, edge or round. Large pieces will seem harder than small, less than a unit difference, and should be allowed for. WLC (9a)

Results of an Inspection on Two Garbe Boilers (Ergebnisse der Untersuchung zweier ausgebauter Garbetrommeln) EBEL. *Die Wärme*, Vol. 55, Sonderheft Sept. 24, 1932, pages 664-670. Describes systematic investigation of unsoundness of drums, warping of the Garbe plates, elastic stresses and possible fracture occurrence, flow of stresses in the overlapped riveted joints and material employed with particular reference to the aging phenomenon. The projected increase of the boiler output was abandoned since the investigation disclosed an advanced state of aging in spite of the short operation time and favorable working conditions so that failure would have occurred inevitably after a further short period of time under the new service conditions. EF (9a)

Magnetographic and X-Ray Tests of Pipe Welds Compared. F. B. DOANE. *Iron Age*, Vol. 131, Feb. 2, 1933, pages 194-196. Gives results of examination of outstanding non-destructive test methods as applied to certain welds. The 3 representative methods selected were the stethoscopic, the magnetographic and the radiographic. Differences in welds were detected by the stethoscope. Results showed that the magnetographic method not only differentiated between good and bad welds but localized faulty areas. The X-ray, in addition to localizing faults, gave more exact indications of their nature and extent, and differentiated between lack of fusion and porosity. States that no one method at present gives promise of replacing the others and that each has its own valuable applications. VSP (9a)

Testing Welded Pipe Lines. R. S. FULLER. *Gas Engineer*, Vol. 57, Sept. 1932, page 521. Statements before the Ninth Annual Distribution Conference of the American Gas Association on soap-water, bending, X-ray and stethoscopic tests. WH (9a)

Classifying Steels by Sparking; Recommended Practice for Routine Inspection. W. G. HILDORF & C. H. MCCOLLAM. *Metal Progress*, Vol. 23, Feb. 1933, pages 23-27. Prepared for the Recommended Practice Committee, A. S. S. T. Spark testing is intended for the separation or prevention of mixed materials, not as a substitute for chemical analysis. It is fast, convenient, economical and accurate with proper regard for its limitations. As the steel is held in contact with the wheel, particles of metal are torn loose so rapidly that the temperature is raised to incandescence. The trajectory of the sparks is called the carrier line. When C is present forks or bursts are noted. They are due to the burning of solid C which changes from solid to gas so rapidly an explosion occurs. As C increases the size and intensity of the bursts increase. A dark cabinet is a necessity for observation. The spark stream should be adjusted by wheel pressure to 12 in. in length. Too high a pressure gives apparently higher C. The sheaf of sparks is divided into wheel sparks, center area, and tail sparks. The carrier lines, the bursts and characteristic sparks are to be observed. The spark burst or C spark is the most useful part of the picture and is affected by alloying elements which retard or accelerate it. The Mo spark is an orange colored spear point on the end of the carrier line and separated from the wheel spark. C sometimes obscures it. Ni sparks are tiny blocks of brilliant white light, located near the wheel in low C steel, in the burst in high C steel. Si suppresses the C spark, the carrier line is shorter and generally ends in a white flash of light. W sparks are dull red. The equipment and training required for spark testing are specified. WLC (9a)

An Interpretation of the Deep Acid Etch Test as Applied to Tool Steels. J. P. GILL & H. G. JOHNSTIN. *Transactions American Society for Steel Treating*, Vol. 21, Apr. 1933, pages 354-384. Paper presented at Buffalo Convention, Oct. 1932. Results of etch tests on alloy tool steels to show different results on structure and solubility with different acids are presented. Effects of etching are different for same steel if annealed or hardened or hardened and drawn. Cracks from etching are mentioned. The "open grain" condition, center porosity, nonmetallic inclusions, metallic segregates, internal cracks, dendrites, pattern effect, flow lines, surface defects and soft spots are briefly discussed and illustrated with macrographs. The authors contend that the etching test alone is insufficient to reject a steel but has value in connection with other tests. Includes discussion. 17 references. WLC (9a)

Non-Destructive Analysis. ALBERT PORTEVIN. *Metal Progress*, Vol. 23, Mar. 1933, pages 52, 54. Non-destructive analysis divides into one class requiring a very small quantity of matter and leaving a trace on the surface, and another class which cannot bear even this small amount of damage. Localized hardness tests, drop etching test for corrosion, and micrographical examination belong in the 1st class. Density determinations, elastic and surface tests belong in the 2nd class. These indirect tests require much knowledge of the connection between these properties and the analysis. More direct tests are the spectroscopy of sparks and electrolytic impression. The latter test is by placing a reactive paper on the specimen, a metallic plate on the paper, applying a conductive solution which gives a characteristic colored precipitate when a current is passed, the piece being the anode. By this method Ni may be revealed in a few seconds. WLC (9a)

The Need and Value of Inspection. P. M. POTTENHAM & H. R. COTTERILL. *Inspection*, Vol. 4, July 1933, pages 1-15. Deals with the importance of inspection of bought goods and the benefits secured. Kz (9a)

Physical and Mechanical Testing (9b)

W. A. TUCKER, SECTION EDITOR

1 **Effect of Linear Stress on Ball Pressure Hardness (Der Einfluss eines linearen Spannungszustandes auf die Kugeldruckhärte)** HANS KOSTRON. *Metallwirtschaft*, Vol. 12, Aug. 18, 1933, pages 473-476. Steel test pieces were subjected to various degrees of tensile stress in a testing machine and were tested for hardness with a portable ball pressure tester while under stress, as well as before and after. As the tensile stress is increased the hardness impressions become more and more out of round. In a series of tests made with various ball pressures on soft steel the hardness before and after application of tensile stress was identical below the yield point of the steel. Above the yield point the hardness after stressing increases over the original, giving a measure of work hardening. The hardness during stress is always below that after stressing. The curves showing the difference between hardness after and during stressing in relation to tensile stress bend sharply upward at a point below the yield point. At the yield point there is a break in the curves, they start at a much lower point and continue upward again. Compression stress has no effect on the hardness. 5 references. CEMp (9b)

Minimum Dimensions of Test Samples for Brinell and Diamond Pyramid Hardness Tests. G. A. HANKINS & C. W. ALDOUS. *Journal Institute of Metals*, Vol. 53, Dec. 1933, pages ccxvi to ccxxxv, Paper No. 653. The work was carried out with the object of determining the minimum dimensions of a specimen required to give the correct Brinell and diamond-pyramid hardness. Materials tested ranged from annealed Cu to hardened spring steel. Results indicated that the Brinell hardness was independent of the width of the specimen when the width was 4½ times the diameter of the impression. When the width was only 2¼ times the diameter 2 of the impression the diameter was about 5% too great. These held independently of the material tested. The thickness at which the Brinell impression was independent of the thickness varied with the material tested, and with thin materials the impression was too large for some materials and too small for others. The ratio of sample thickness to depth of impression necessary to give correct results was 6 for mild steel, 15 for annealed Cu, and from 21 to 25 for spring steels. With the diamond pyramid substantially correct results were obtained when the ratio of the thickness of the sample to the impression diagonal was 1½. For soft Cu and brass, however, a larger ratio was required. JLGp (9b)

Notch-Impact-Bending Test and Its Conditions of Testing (Die Kerbschlagbiegeprobe und Ihre Versuchsbedingungen) HELMUT HOLDT. *Veröffentlichungen des Zentral--Verbandes der Preussischen Dampfkessel-Ueberwachungs Vereine*, Vol. 8, pages 3-66. It has been recognized that the notch-impact-bending test offers an excellent means for judging materials, in particular for steel. A much wider application is advocated and the basis for proper testing conditions were thoroughly investigated. A numerical comparison of different test results requires, however, that all test conditions as to shape of sample, shape of notch, impact energy and impact velocity, and temperature are the same; the depth of the notch is of no influence in samples of the same section of fracture. It was further found that impact energy, impact velocity, depth of notch and dimensions of the samples with the same ratio width to height have no essential influence on the average impact strength changes with the width of the sample; with increasing width the impact strength decreases, and the more so the lower the deformation susceptibility of the material is (the less the material is liable to be deformed). Average impact strength and percent decrease of average impact strength with increasing width of the sample give together a measure of quality for the impact resistance and the capacity for deformation of the materials. These quality numbers can be determined at all testing places if temperature and shape of notch are the same, the former to be determined by the purpose of application of the material. Suggestions for the best notch shape are discussed. 49 notes and 64 bibliographical references. Hap (9b)

Strength Tests of Thin-Walled Duralumin Cylinders in Pure Bending. EUGENE E. LUNDQUIST. *National Advisory Committee for Aeronautics, Technical Note* No. 479, Dec. 1933, 16 pages. Cylinders of duralumin, 0.011″, 0.016″ and 0.22″ in wall thickness and 7.5 and 15 radii with lengths varying from 1.87″ to 37.5″ were tested in bending. The type of failure was similar to that for cylinders in compression (Technical Note No. 473) and can be calculated from the equation of the form, stress in outer fiber = $K_b E$. Values of K_b, which is a non-dimensional coefficient, are given. The bending strength was from 30 to 80% greater than the compression strength of similar cylinders. JRJp (9b)

A Method of Hardness Measurement of Materials. MANABU NAKANO, TOSHIO WATANABE & MINORU FUKUTOME. *Journal of the Society of Mechanical Engineers, Japan*, Vol. 36, May 1933, pages 322-325. Paper read before the 222nd Meeting of the Society of Mechanical Engineers, Oct. 28, 1932. Description of a new method of hardness measurement. The hardness number is given by the deflection of an electrometer which indicates the intensity of the piezo-electric potential caused by a falling steel ball in the quartz crystal mounted under the specimen. Results of this method show very close agreement with those obtained by other hardness testers. Kz (9b)

Effect of Test Pressure on Strength of Iron Castings. J. H. LIST. *Mechanical World & Engineering Record*, Vol. 93, Mar. 24, 1933, page 282. Branch pipes were cast with a mixture of 50% No. 3 pig iron, 20% No. 3 East Coast hematite, and 30% good clean heavy machinery scrap, and the metal was run very hot. The first casting was tested before machining. While under test after machining the casting fractured at 300 lbs. pressure. The second casting showed the same result. Failure could have been due to one of 3 causes: (1) inferior Fe, (2) weakness in design, (3) fatigue of the Fe after being strained on the first test. Investigations eliminated the questions (1) and (2). The third casting was tested only after a machining and withstood pressure of 350 lbs./in.^{2} Kz (9b)

The Interrelationship of the Rockwell, Brinell and Shore Hardness Numbers. W. E. J. BEECHING. *Metal Industry*, London, Dec. 29, 1933, page 641. For quick conversion of hardness numbers the formulas are given:

$$\text{Brinell number} = \frac{K}{130 - \text{Rockwell ball number}} \text{ or}$$

$$= \frac{C}{(100 - \text{Rockwell cone number})^2}, \text{ and}$$

$$\text{Shore number} = \frac{K}{10\,(130 - \text{Rockwell number})} + 10$$

$$= \frac{K_1}{130 - \text{Rockwell number}} + 10$$

Hap (9b)

Diamond Pyramid Indentation Test of Copper and Copper-Rich Alloys in the Form of Thin Strips. MAURICE COOK & EUSTACE C. LARKE. *Metal Industry*, London, Vol. 42, Mar. 17, 1933, page 303. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 314. Hap (9b)

Interior Stresses in Large Forgings (Eigenspannungen in grossen Schmiedestücken) G. KIRCHBERG. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, July 8, 1933, page 732. See "Natural Stresses in Large Forgings," *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 250. Ha (9b)

Limits of Errors of Shop Methods of Brinell Hardness Tests (Fehlergrenzen der betriebsmässigen Brinell-Härteprüfung) MAX MOSER. *Stahl und Eisen*, Vol. 53, Jan. 5, 1933, pages 16-18. Differences in hardness figures obtained in different plants and institutes were analyzed. When using the prescribed method with a 10 mm. ball and 3000 kg. load shop tests do not need to differ more than ± 5% when applied properly. Materials of more than 600 hardness, however, show greater differences, especially if smaller balls are used. It is recommended to apply the Brinell test only for soft and medium hard steels. For material with a hardness of more than 600 a cone or still better a quadrilateral pyramid gives better and more uniform results than the ball. Hap (9b)

Notched-Bar Tests. MAX MOSER. *Transactions American Society of Mechanical Engineers*, Vol 55, *Applied Mechanics Section*, July-Sept. 1933, pages 105-110. A translation and discussion of the paper in *Zeitschrift Verein deutscher Ingenieure*, Vol. 76, 1932, page 257 (See *Metals & Alloys*, Vol. 4, May 1933, page MA 144) on the standardized notched bar for impact tests; the use of such standard bar facilitates comparison of different methods and observers. 10 references. Hap (9b)

Stresses in Castings (Spannungen in Gussstücken) J. MATHAR & E. HUGO. *Die Giesserei*, Vol. 20, Mar. 17, 1933, page 114. By drilling a small hole in the casting and measuring its deviation from the true cylinder very exact measurements could be made of stresses present in the casting. Some of the results of such measurements are that green sand casting has always greater inner stresses than dry casting, that for normal cast iron poor in Si and C stresses are smaller with increasing melting and pouring temperature and that they are higher in Fe rich in Mn but poor in C and Si. Hap (9b)

The Serrated Discontinuity on Load-Extension Diagram and Age-Hardening of Metals and Alloys. TADASHI KAWAI. *Kinzoku no Kenkyu*, Vol. 10, July 1933, pages 302 to 330 (In Japanese); *Science Reports Tohoku Imperial University*, Vol. 22, 1933, pages 354-374 (In English). The present writer studied the serrated discontinuity on the load-extension diagram of high temperature tension test in connection with his study on the age-hardening of cold worked metals and alloys. The results obtained are: (1) If a stretched iron bar be tested for yield point immediately after stretching, neither increase nor serrated discontinuity occurs in yield point, but if it is tested after a rest at an ordinary temperature or heating, the yield point is considerably raised and serrated discontinuity is observable. (2) If a small stretch and ageing are successively applied on a test-piece of iron until it is broken, the form of load-extension diagram will be changed just as the one obtained by high temperature test, showing serration on it. (3) In iron and steels, α brass, phosphor bronze, nickel and duralumin, the yield point after stretching is raised by ageing or heating at a temperature within a particular range, but in the case of copper and aluminum, the yield point merely decreases by ageing or heating. (4) Serrated discontinuity occurs on the load-extension diagram when the metals and alloys, which undergo age-hardening after stretching are tested at a temperature within the range stated in the item 3. (5) Serrated discontinuity on the load-extension diagram can be explained by a successive action of yielding and ageing. KT (9b)

Studies on the deep drawing of sheet as measured by the Erichsen method (Untersuchungen über den Tiefungswert von Blechen nach der Erichsen-Methode) FR. DÖRGE. *Zeitschrift für Metallkunde*, Vol. 25, July 1933, pages 165-168, 210-214. The interpretation of the Erichsen test for deep drawing capacity of sheet metal is discussed. Penetration-load curves for Al, Cu, brass, and bronze sheets are given and discussed mathematically. It is concluded that the drawing test is essentially similar to a simple tensile test. RFM (9b)

The determination of the initial ball impression hardness (Ein Beitrag zur Ermittlung der Anfangshärte bei der Kugeldruckprobe) E. FRANKE. *Zeitschrift für Metallkunde*, Vol. 25, Sept. 1933, pages 217-219. The initial ball impression hardness, H_A, is determined by taking a series of Brinell impressions at different applied loads (giving Brinell hardness No. H), then determining the Shore scleroscopic hardness numbers of the work-hardened layer (S) at the bottom of the impression and also of the unstrained sample (S_o), and applying the relationship $H_A = \frac{H.S_o}{S}$. A similar treatment may be applied using pendulum hardness instead of scleroscopic hardness. The values of initial hardness obtained in this way are thus independent of work-hardening effects and are more representative of the original material. The method is simple enough to be used in practice. RFM (9b)

The relation between static and dynamic loading (Die Beziehungen zwischen statischen und dynamischer Beanspruchung) B. GARRE. *Zeitschrift für Metallkunde*, Vol. 25, Sept. 1933, page 206. The law of constant breaking work proposed by Ljungberg (*Proceedings Third International Congress Technical Mechanics*, Stockholm, 1930, Vol. II) is known to be approximately (10%) true for hard materials but to be inapplicable to soft materials. The difference between the work consumed in dynamic loading and that in static (tensile) loading lies in the fact that the breaking work in static loading is not characteristic of a material, but varies with testing speed; that the dynamic work varies with external conditions and with the momentary state of the materials. It does not appear advisable to calculate dynamic strengths from indeterminate physical values. RFM (9b)

On the Application of Interference Fringes to Stress Analysis. MAX MARK FROCHT. *Journal Franklin Institute*, Vol. 216, July 1933, pages 73-89. Problem of stress analysis and its relation to the failure of materials is one of the most interesting and difficult problems of applied science today. Average stresses, or approximations of stresses, are used by engineers to figure designs of structures or machines. These average stresses may frequently be far different from actual conditions, and the engineer uses his factor of safety gathered from broad experience. The development of the theory of elasticity has for its main purpose the study of the exact stress distribution in contrast to the average stress distribution. While the theory is too involved, there is an experimental method for the study of exact stress distribution which is rather promising. The author suggests a method and gives the preliminary work for the determination of P + Q, the sum of the principal stresses. This method eliminates the older methods of point by point exploration. It can be carried out effectively with metal models, as well as with the present and original glass models used for the purpose. DTR (9b)

Running Qualities of Bearing Metals (Über die Ermittlung der Laufeigenschaften von Lagerwerkstoffen) W. LINICUS. *Schriften der Hessischen Hochschulen*, 1933, No. 2, pages 13-19. Paper before Werkstofftechnisches Kolloquium der Staatlichen Materialprüfungsanstalt an der Technischen Hochschule Darmstadt, June 24, 1933. Briefly outlines requirements bearing metals must meet. Most important property in running tests is the loadability. This property is defined as the upper limit of the surface pressure which the bearing metal stands without destruction of the lubricating film. This property was studied in extensive running tests of different bearing metals on the Kammerer-Welter machine. Technically pure Al and Al alloys are suitable only for small loads and running speeds, Zn alloys behave better, at high speeds white metal W M 80 shows high loadability, a special bearing metal with higher melting point than Sn alloys nearly attains the values of high Pb bearing bronze. Wear tests were further made as applied by the Bearing Testing Station of the railroad repair shops of the German Railway at Göttingen. The results show that white metal has less than half the wear of Pb bronze, the above mentioned special bearing metal is far superior to white metal bearings, the rather soft Pb bronzes possess the highest resistance to wear. Since the wear tests on the mentioned machine take too much time and require great care tests were also made on a simpler wear testing machine as developed by Koch. The results of these tests are in accordance with those on the Göttingen machine. GN (9b)

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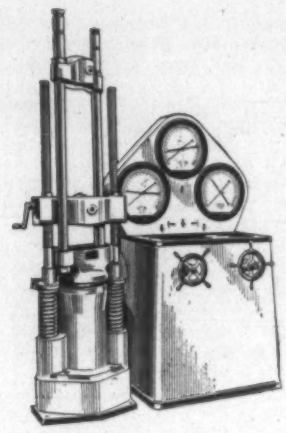

The wide use, in this country, of hydraulic testing machines has been a development of the past few years. There were, of course, a few outstanding precision testing machines having mutually independent load producing and load measuring hydraulic systems, such as those designed and built by A. H. Emery for the Watertown Arsenal and the National Bureau of Standards; but their cost limited their use to laboratories in which price was a secondary consideration.

Therefore, when a testing machine in which load was indicated by an hydraulically-actuated pointer before a graduated dial was made commercially available to materials engineers, there were doubts as to its reliability and accuracy.

Today, the records of service of Southwark-Emery hydraulic machines, subjected to constant use and frequent calibration in outstanding materials laboratories, have so far exceeded expectations that the merit of these machines is universally recognized.

In addition, their present wide distribution in almost every kind of industry, their use in the most renowned of the engineering school laboratories, the uniform owner satisfaction, and the fact that almost every important manufacturer of testing equipment in this country now offers machines of this general type, is conclusive evidence of the position of leadership which Southwark-Emery has achieved and will continue to hold in the materials testing field.

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New Method of Determination of Elasticity Moduli (Une Nouvelle Methode de Determination des Modules d'Elasticite) P. Le Rolland & P. Sorin. *La Technique Moderne*, Vol. 25, July 1933, page 472. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 350. FR (9b)

Testing Machine for Pressures up to 1500 Tons (Prüfmaschine für Drücke bis 1500 t.) O. Graf & E. Brenner. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, June 10, 1933, page 609. Brief description of a hydraulic testing machine for compression tests up to 1500 tons pressure in the Technical University Stuttgart. Ha (9b)

Interpretation of the Tensile Test (with Reference to Lead Alloys). B. P. Haigh & Brinley Jones. *Engineering*, Vol. 135, Mar. 17, 1933, pages 311, 314-316; *Engineer*, Vol. 155, Mar. 17, 1933, page 266. Short abstract of paper read before the Institute of Metals, Mar. 1933. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 350. LFM (9b)

Importance of Spatial, Plastic and Inhomogenous States of Stress as Regards the Problem of Permissible Loading (Die Bedeutung räumlicher, plastischer und inhomogener Spannungszustände für die Frage der zulässigen Beanspruchungen) Walter Buchmann. *Schriften der Hessischen Hochschulen*, 1933, No. 2, pages 58-66. Paper before Werkstofftechnisches Kolloquium der Staatlichen Materialprüfungsanstalt an der Technischen Hochschule Darmstadt, June 24, 1933. Theoretical considerations on the problem in question with due regard to the relations between states of stress and structure of material. GN (9b)

The Mechanical Properties of Austenitic Stainless Steels at Low Temperatures. E. W. Colbeck, W. E. MacGillivray & W. R. D. Manning. *Foundry Trade Journal*, Vol. 48, June 15, 1933, page 418. An extended abstract of a paper read at a meeting of the Institution of Chemical Engineers (British), accompanied by two diagrams which illustrate a description of the testing machine used by the authors in their experiments on the tensile strength of the materials they investigated. OWE (9b)

Stability of the Plastic Deformation of the Cold Worked Materials. Shun Futjita & Yukichi Asakawa. *Journal of the Society of Mechanical Engineers Japan*, Vol. 36, July 1933, pages 460-464. Paper read before the 222nd Meeting of the Society of Mechanical Engineers, Oct. 28, 1932. When a mild steel specimen is clamped to a torsion tester, in which the twisting moment can be measured by a pendulum type dynamometer, and is kept in loaded condition, the deflection of the dynamometer pendulum gradually decreases accompanied by a slight oscillating motion in accordance with the time elapsed. The authors point out that this is one of the most general phenomena of the plastic deformation of the cold worked materials. Kz (9b)

New Bend Testing Machine. A. C. Blackall. *Wire & Wire Products*, Vol. 8, Sept. 1933, pages 270, 284. A machine developed by the Sheffield University Research Department and the Patented Steel Rope Wire Association is described in which the dies are interchangeable so that the same machine can test wires of widely differing diameter. Ha (9b)

Variability of Damping of Materials (Die Veränderlichkeit der Werkstoffdämpfung) A. Esau & H. Kortum. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Oct. 21, 1933, pages 1133-1135. The damping properties of a material can not be judged by results of tests of short duration; it is necessary to determine the variation of damping and the range of damping in endurance tests if the behavior of the material is to be fully defined. Pendulum testing machines are the most suitable kind for these tests. Ha (9b)

Investigation of an Electrically Welded High-Pressure Drum (Untersuchung an einer elektrisch geschweissten Hochdrucktrommel) W. Jamm & O. Weinrich. *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Aug. 19, 1933, pages 901-904. An arc-welded high-pressure drum with flanged bottoms made of steel of high tensile strength was subject to measurements of elongation; the stresses were measured in all directions by Huggenberg elongation meters. Curves, diagrams and microphotographs show the excellence of the material of 47-56 kg./mm.^{2} strength. The elastic limit of the drum was reached at 195 kg./cm.^{2} pressure. Fracture of the drum occurred at 303 kg./cm.^{2} Ha (9b)

Investigations for the Determination of Ratios between Values of Notch-Toughness at Different Dimensions of Samples (Versuche zur Ermittlung von Verhältniszahlen zwischen Kerbzähigkeitswerten bei verschiedenen Probenabmessungen) K. Baatz. *Veröffentlichungen des Zentral-Verbandes der Preussischen Dampfkessel-Ueberwachungs-Vereine*, Vol. 8, pages 67-87. A great number of materials, especially boiler plates, were tested by impact and with different dimensions of the samples to find a common conversion factor for the results which are obtained by the official test method; for the materials under test this factor was 2.2-2.3 for one group of materials, and 2.6-2.7 for the other. It is, however, not quite conclusive whether such factors are always admissible, and a definite testing method for boiler plates has not yet been devised. 14 references. Ha (9b)

A New Method of Testing Cast Iron (Ein neues Verfahren der Gusseisenprüfung) B. Osann. *Die Giesserei*, Vol. 20, Feb. 17, 1933, pages 63-65. Bending strength and deflection are measured as before but not with a sample of standard dimensions; the diameter of the sample is selected according to the wall thickness of the casting and the sample tested on a new testing machine. The samples are cast in steps of 2.5 mm. and tested without being machined; the diameter is made like the wall thickness which, naturally, can be done only up to about 60 to 70 mm. as for greater wall thicknesses the machine would become too cumbersome to permit economical testing. The bending test with such samples gives values more nearly representing the character of the casting. Whole procedure of a test is described in detail. Ha (9b)

Internal stresses in various ferrous materials (Tensioni interne di alcuni materiali ferrosi) V. Montoro. *La Metallurgia Italiana*, Vol. 25, May 1933, pages 339-344. Using the methods previously described by the author, the internal stresses in ferrous materials have been calculated. Because of experimental difficulties (lack of homogeneity, of equilibrium, etc.) the values obtained must be considered as giving only the orders of magnitude. Several microphotographs are shown. AWC (9b)

Testing Drawing Qualities of Sheet Steel. Fritz Eisenkolb. *Metal Stampings*, Vol. 5, Oct. 1932, pages 605-608; Nov. 1932, pages 659-662; Dec. 1932, pages 701-702, 706; Vol. 6, Jan. 1933, pages 33-34. Condensed translation from *Stahl und Eisen*, Vol. 52, Apr. 14, 1932, pages 357-364. See *Metals & Alloys*, Vol. 3, Nov. 1932, page MA 322. MS (9b)

Diamond Pyramid Indentation Testing of Thin Strip. Maurice Cook & Eustace C. Larke. *Sheet Metal Industries*, Vol. 6, Apr. 1933, pages 767-769, 775; *Engineering*, Vol. 135, Mar. 31, 1933, pages 364, 367-369. See *Metals & Alloys*, Vol. 4 Oct. 1933, page MA 314. LFM + AWM (9b)

Recommended Practice for Testing Bolts, Screws, Nuts, Studs and Pins. Subcommittee on Bolts, A.S.S.T. *Metal Progress*, Vol. 23, Mar. 1933, pages 25-26, 58. Notes on the various tests, some of them new, for testing this class of work are given. The tests noted are appearance and finish, mechanical inspection, hardness, tensile, elongation, head, bend, shank fracture, impact, shear, thread stripping, macrostructure and microstructure, casting inspection, and the distribution of results. WLC (9b)

Empirical Law Governing Behavior of Some Plastic Bodies Under Compression. (Ueber eine empirische Regel im Verhalten einiger plastischer Körper gegen Druck.) K. Przibram. *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse*, Abt. II a, Vol. 141, No. 1-2, 1932, pages 63-69. Small NaCl, Cu and Pb test pieces were submitted to compression between polished steel plates without lubrication. For these plastic materials, a range of pressure and "slenderness ratio" (Schlankheitsgrad") was established in which the reduction in height of the sample can be represented as a function of the pressure and slenderness ratio. WH (9b)

Destructive Test of a Model Wye. D. E. Larson. *Welding Engineer*, Vol. 17, Nov. 1932, pages 25-28. A two-way wye bench was tested to destruction to find means for improvement of the design and manufacture. The hydrostatic test showed 82000 lbs./in.^{2} circumferential stress when the welded structure failed while plates used showed only 61000 and 70650 lbs./in.^{2}, respectively before and after the test. Savings in labor and material over a riveted and bolted construction is considerable. Ha (9b)

Nondestructive Testing is Increasing in Usefulness. *Steel*, Vol. 90, May 23, 1932, pages 29-30. Abstract of a paper by Robert F. Mehl entitled, "Nondestructive Testing Methods in the Iron and Steel Industry," presented at the annual spring meeting of the American Iron & Steel Institute in New York, May 19, 1932. See *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 250. JN (9b)

A New Hardness Ratio. H. S. Kipling. *Automobile Engineer*, Vol. 22, Nov. 1932, page 563. See *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 250. RHP (9b)

Hardness and Stress in Material. (Härte und Werkstoffspannungen.) H. Kostron. *Mitteilungen des Technischen Versuchsamtes Wien*, Vol. 21, 1932, pages 17-31. Results of hardness tests can be greatly influenced by additional stresses existing or produced in the tested material. All impression tests and also rebounding tests showed a reduction of hardness by accompanying tensile stresses. Impressions with straight and curved cutting edge give hardness values which depend on the angle between cutting edge and direction of tensile stress. 6 references. Ha (9b)

Elongation of Cylindrical Tensile Test Bars. (Allungamento dopo rottura di barrette cilindriche di trazione.) G. Germeau. *La Metallurgia Italiana*, Vol. 25, Apr. 1933, pages 235-249. Mathematical. AWC (9b)

Ductility Index for Tinplate. Frank J. Gavin. *Metal Stampings*, Vol. 5, May 1932, page 316. Describes method of determining ductility of stock for crown caps after secondary anneal. Following the final anneal after cold rolling, the individual pots were sampled and rectangles 3" by 2" were stamped from the sheets. These were put through a 3-gang die, first bending the specimen across the middle at 90°, next to 150°, and finally to 180°. The radius of the bend was then examined by eye or with low magnification and the condition of the edge noted for degree of fracture. Experience showed that certain degrees of fracture were permissible without re-annealing. Operators required some little training to determine this permissibility. MS (9b)

Test Files Made of Nitrided Steel. Federico Giolitti. *Metal Progress*, Vol. 23, Mar. 1933, pages 45-46. Scratch hardness determination has been studied by the F.I.L.P. file factory of Turin. Results differ somewhat from the Nicholson Co. results. Tests on a large number of steels were made to compare Vickers diamond indentation hardness and scratch hardness by Martens diamond scratch test with file hardness. File hardness paralleled the other tests in a general way. Nitrided steel files for hard materials up to Rockwell C-68 were made of constant hardness by eliminating the superficial layer of nitrides. 1% Al steels had brittle nitrided teeth. Low Al and nitriding steels without Al have been made into files of regular hardness up to 1000 Brinell-Vickers. The form of the file teeth is of great importance. WLC (9b)

Portable Hardness Testing Machine, with Diamond Pyramid Indenter. S. R. M. Porter. *Journal Scientific Instruments*, Vol. 10, Jan. 1933, pages 18-20. A machine designed to enable hardness tests to be made on large-sized or fixed surfaces by the standard method of applying a steady load to an indenter for a definite time. By using a diamond pyramid with a high power microscope, instead of using the usual Brinell ball, the load required can be kept small enough to be applied directly by hand, without requiring a clamping device and lever or screw. Method of operating and source of error discussed. RAW (9b)

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Fatigue Testing (9c)

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals.

H. F. MOORE, SECTION EDITOR

Some Comparative Corrosion Fatigue Tests Employing Two Types of Stressing Action. H. J. Gough & D. G. Sopwith. *Iron & Coal Trades Review*, Vol. 126, June 30, 1933, pages 1005-1006; *Engineering*, Vol. 136, July 21, 1933, pages 75-78. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 350. LFM + Ha (9c)

Effect of Degree of Cold-hardening by Drawing on Fatigue Limit of Soft Steel (Influence du degré d' écrouissage a l' étirage sur la limite du fatigue de l'acier doux) R. Cazaud. *Comptes Rendus*, Vol. 196, Mar. 6, 1933, pages 696-698. Method is that previously described by author (*Comptes Rendus*, Vol. 192, 1931, page 1558) and applied to an open hearth steel (0.18% C). Results, shown in tables, indicate that fatigue limit increases almost proportionally to an apparent elastic limit and the tensile strength. Whereas in the annealed state the S-N curves of this steel consist of two well-defined linear sections, in the cold-worked state the curves become increasingly smooth as deformation increases. OWE (9c).

Fatigue Tests of Helical Springs and Notes on Sundry Results of the Tests. C. T. Edgerton. *Wire & Wire Products*, Vol. 8, July 1933, pages 210-211, 220-221. The report No. 2 of the subcommittee on heavy helical springs is reprinted and discussed. A number of tests are described but no definite conclusion can be drawn; a maximum of 70000 lbs./in.^{2} fiber stress under the test conditions might be given as endurance limit. Recommendations for further tests are made. Ha (9c)

Vibration and Fatigue in Electrical Conductors. A. E. Davison, J. A. Ingles & V. M. Martinoff. *Transactions American Institute Electrical Engineers*, Vol. 51, Dec. 1932, pages 1047-1051. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 350. Ha (9c)

An "Overnight" Test for Determining Endurance Limit. H. F. Moore & H. B. Wishart. *American Society for Testing Materials Preprint* No. 36, June 1933, 7 pages; *Iron & Coal Trades Review*, Vol. 127, Aug. 18, 1933, page 243. The theory of the test suggested is that below the endurance limit cycles of repeated flexure increase the endurance limit and presumably the tensile strength, while above the endurance limit cracks begin to develop and, if allowed to spread, reduce the tensile strength. A period of 1,400,000 cycles seems to be sufficient to develop such cracks for the metals tested, with the possible exception of duralumin. The procedure is therefore as follows. Five or six fatigue specimens of a metal are provided. The Rockwell hardness of each is determined. The specimens are then placed in rotating-beam machines, and are subjected to approximately 1,400,000 cycles of stress, which requires about 15½ hours for machines running at 1500 r.p.m. The fatigue machines may be conveniently started in the late afternoon, and then the specimen can be removed early the next morning; hence the term "overnight" test. The stresses for the different specimens cover a range of values on both sides of the estimated endurance limit. After the 1,400,000 cycles of reversed flexure the specimens are removed from the machines and pulled as tension specimens, noting the tensile strength. If any of the specimens breaks before the 1,400,000 cycles its tensile strength is placed at zero. Making corrections proportional to the Rockwell hardness, the test data are plotted with stress applied for the period of 1,400,000 cycles as ordinates and tensile strength, after this period, as abscissas. The endurance limit is taken as the ordinate corresponding to the maximum abscissa of this curve. This method has been checked against long-time fatigue tests for structural steel, cold-rolled steel, brass, monel metal, Ni-steel, Cr-Ni-steel, duralumin, and specimens of cold-rolled steel with sharp notches. The maximum variation observed in endurance limit as determined by this "overnight" test and as determined by the long-time test was 11.8%, for duralumin. (Note by HFM: Further tests indicate that there is some doubt as to the applicability of this method to some non-ferrous metals, at least unless the preliminary 1,400,000 cycles is greatly increased.) Ha+VVK (9c)

The Dependence of Endurance Strength on the Crystal Orientation (Zur Frage der Orientierungsabhängigkeit der Dauerfestigkeit) W. Fahrenhorst, K. Matthaes & E. Schmid. *Die Metallbörse*, Vol. 22, July 16, 1932, page 898. See *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 285. EF (9c)

The Fatigue Resistance of Unmachined Forged Steels. G. A. Hankins & M. L. Becker. *Engineering*, Vol. 132, Sept. 30, 1932, pages 395-396, 402-404; *Iron & Coal Trades Review*, Vol. 125, Sept. 16, 1932, pages 409-411; Sept. 30, 1932, page 502; *Mechanical World & Engineering Record*, Vol. 93, Jan. 13, 1933, page 32. See *Metals & Alloys*, Vol. 4, July 1933, page MA 214. Ha + LFM + Kz (9c)

Roll Breakage. Frederic Bacon. *Blast Furnace & Steel Plant*, Vol. 20, Oct. 1932, page 790; Nov. 1932, page 850. Abstract of paper entitled "Fatigue Stresses with Special Reference to the Breakage of Rolls," read before the South Wales Institute of Engineers. See *Metals & Alloys*, Vol. 2, Apr. 1931, page 80. MS (9c)

Alternating Torsional Stresses on Single Crystals (Verdreh-Wechsel-Beanspruchung an Einkristallen) *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 23, Dec. 28, 1932, page 737. Experiments on Bi aimed at the investigation of sliding processes within the crystal apart from those between crystals. The influences of magnitude of the shear stress and the position of the atom space lattice were noticeable. Kz (9c)

Fatigue Strength (Dauerfestigkeit) *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 23, Oct. 28, 1932, page 620. Not the grain boundaries, but the grains are destroyed due to oscillating stresses. Investigations on single metal crystals did not settle the problem of fatigue. After a primary strain hardening an extensive softening and the influence of the crystal orientation were observed. Experiments proved that plastic deformations in the beginning of the tests vanish on account of the strain hardening resulting in an increase of strength during the first 10,000 changes in stress direction. Direction of rolling shows some effects during alternating tests. Kz (9c)

Fatigue Strength (Schwingungsfestigkeit) R. Colell. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 23, June 4, 1933, pages 319-320; June 11, 1933, page 329. General discussion of fatigue problem with special reference to results of recent investigations. GN (9c)

Fatigue Resistance of Some Foundry Alloys of Aluminum. (Résistance à la Fatigue de Quelques Alliages d'Aluminium de Fonderie.) R. Cazaud. *Bulletin de l'Association Technique de Fonderie*, Vol. 16, Aug. 1932, pages 485-486. Paper at World Foundry Congress, Paris, Sept. 1932. Fatigue test of French Metallurgical Laboratory, Aeronautical Research Branch, is described. Results obtained:

Alloy	Mold	Fatigue Limit
Al-Cu, 8% Cu	Sand	5.5 kg./mm.^{2}
Al-Cu, 12% Cu	Chill	4.8 kg./mm.^{2}
Al-Si, 5% Si	Chill	4.6 kg./mm.^{2}
Al-Si, 12% Si	Chill	5.5 kg./mm.^{2}
Al-Si, 18% Si	Chill	7.1 kg./mm.^{2}

This approximate "fatigue limit" fails to rupture the specimen after 100,000,000 cycles. WHS (9c)

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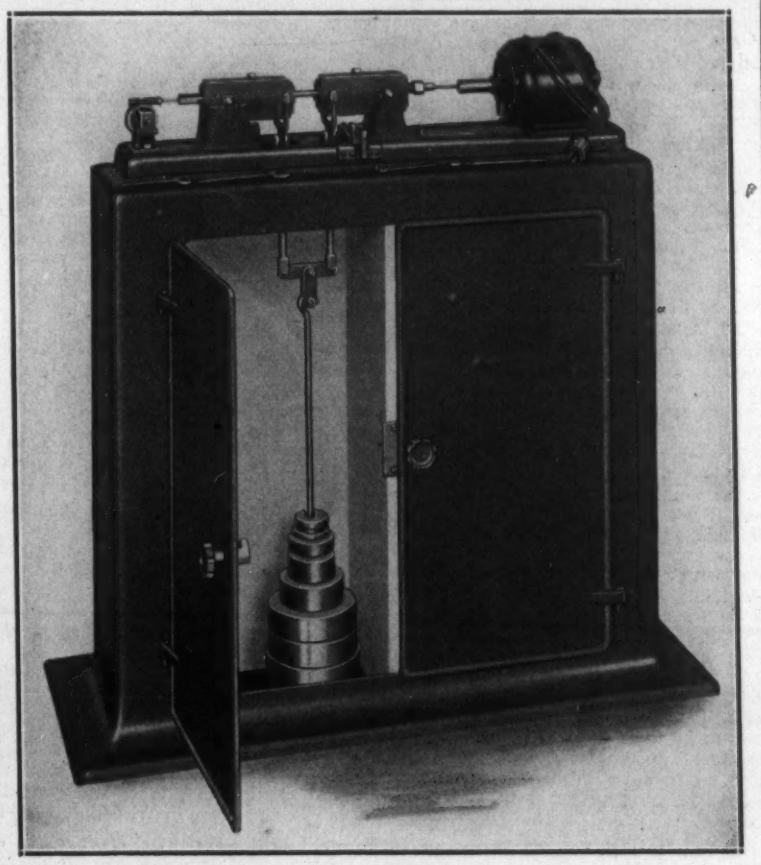

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Endurance of Threaded Bolts as Influenced by Form, Manufacture and Material (Dauerfestigkeit von Schrauben, ihre Beeinflussung durch Form, Herstellung und Werkstoff) W. STAEDEL. VDI—Verlag, Berlin, 1933. Paper, 6 x 8½ inches, 102 pages. Price 8 RM. No. 4 of *Mitteilungen der Materialprüfungsanstalten der Technischen Hochschule Darmstadt.*

Repeated tensile impact stress was put on bolts by a falling weight applied to and lifted from the nut six times a second. The endurance tests were carried to 2 million cycles. Eight machines were kept running day and night for 2½ years.

With a thread diameter of 10 mm. the best endurance under repeated tension impact was obtained when the shaft diameter was reduced to 6 mm. When the shaft was not turned down, the longer the free thread beyond the nut, toward the head, the better.

Rounding the notch of the thread from a radius of 0.1 to 0.2 mm. doubled the endurance limit.

A cut thread on a non-heat-treated .33 C steel and a rolled thread put on before heat-treating, the bolt then being heat-treated gave about the same tensile strength (around 120,000 lbs./in.^{2}) for the two bolts and the same endurance. When the thread was rolled on after heat-treating (to about 100,000 lbs./in.^{2} tensile strength of the stock) the tensile strength of the bolt was still about the same, but the tensile impact endurance limit increased 6 fold.

Cold-working of the previously cut threads on a soft steel bolt doubled the endurance limit of the bolt.

Bolts made to the same dimensions on automatic machines of different steels in different plants showed very wide scatter in endurance. Some comparisons were made under fully comparative conditions on carbon and Ni Cr steels, and the endurance of the bolts rose with the strength of the material.

A bolt with a reduced section next the thread and with two full sized sections (for spacing purposes) on the shaft, all with generous fillets and with the notch of the thread also well rounded, is advocated for resisting repeated tension. Special attention is paid to connecting rod bolts.

The experiments are tabulated in detail and good and bad designs illustrated.
H. W. Gillett (9c)-B-

Metallurgical Analysis by the Spectrograph. D. M. SMITH. Research Monograph No. 2. British Non-Ferrous Metals Research Association, London, 1933. Cloth, 6¼ x 10 inches, 114 pages. Price 10s. 6d. Metals that are very pure involve great difficulties in the chemical determination of the tiny amounts of impurities present, though those impurities do or may have an influence on the properties and hence have to be determined. Spectrographic methods tend to solve this problem for Cu, Pb, Sn and Zn, but their application is none too simple in the hands of relatively inexperienced operators. This volume summarizes the experience and the technique accumulated in eight years of study by the British Non-Ferrous Metals Research Association.

The work was chiefly done with a small size spectrograph of a type not too expensive for consideration where such problems are met so the results are applicable to plant problems and not merely to those of a research laboratory.

The arc and spark methods are discussed as is the technique of making comparisons with "knowns." Detailed discussion of the application of the methods to the four metals mentioned above with plates and tables, follows. The order of accuracy to be expected is fairly discussed and interesting comparisons given to show composition by chemical analysis and by spectrographic methods in the hands of different observers using different equipment.

It takes some practice before a high grade technician could turn out reliable quantitative analyses by the spectrograph, but this book should greatly reduce the period of apprenticeship required. It is clearly written and is not over-enthusiastic, recognizing the distinct limitations of the methods as well as their large possibilities.

While it deals in detail only with Cu, Sn, Pb, Zn and their impurities, the general mode of attack will be helpful to those dealing with other spectrographic analyses.
H. W. Gillett (9c)-B-

The Static and Fatigue Properties of Brass. J. B. KOMMERS. *University of Wisconsin Engineering Experiment Station Bulletin* No. 76, 1933, 38 pages. Somewhat augmented account of work previously reported in the Proceedings of the American Society for Testing Materials. See *Metals & Alloys*, Vol. 2, Oct. 1931, page 215. Includes 14 tables of data, 15 micrographs, 14 S-N curves.
HWGp (9c)

Endurance Strength of Nitrided Samples (Ueber die Dauerfestigkeit von nitrierten Proben) R. MAILÄNDER. *Technische Mitteilungen Krupp*, No. 2, 1933, pages 53-58; *Zeitschrift Verein deutscher Ingenieure*, Vol. 77, Mar. 11, 1933, pages 271-274. Nitriding increases the resistance of thin parts which are subject to alternating bending or torsion; it has the further advantage that the ideal endurance strength of the material can be used as basis of calculation for uniform alternating stresses or, in thick parts, with alternating stresses of any kind without having to pay much attention to the finish of the surface. The presence of grooves, flanges, etc. does not reduce the vibration strength of nitrided samples even if the change of section is rather abrupt (small radius of rounding-off), while in not nitrided samples this is very dangerous. Notches made before nitriding have no influence on endurance strength except very deep ones. Cd plating or sherardizing increases the life under alternating stresses with simultaneous moistening with tap-water over that of unprotected samples but this does not give a perfect protection; the endurance strength of nitrided samples is not influenced by moistening with water.
Hap (9c)

Effect of the Cross-Section of the Specimen on the Endurance Limit of Steel (Einfluss des Probendurchmessers auf die Biegeschwingungsfestigkeit von Stahl) R. FAULHABER, H. BUCHHOLTZ & E. H. SCHULZ. *Stahl und Eisen*, Vol. 53, Oct. 26, 1933, pages 1106-1108; *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke Aktiengesellschaft Dortmund*, Vol. 3, June 1933, pages 153-172. Rotating beam fatigue tests were made of annealed 0.1%, 0.3%, and 1% C steel; heat treated Cr-Ni steel VCN 35; and structural steel 52. The specimens were either polished, ground, or turned, or else contained notches 0.1 mm, 0.5 mm, and 2 mm deep; they also varied in cross-section from 7.52 mm to 13.65 mm. The thicker samples showed appreciably lower endurance limits, this effect being greater with increasing roughness of surface or depth of notch, and with increasing hardness of the steel.
Ha+SEp (9c)

The Effect of Surface Finish on the Fatigue Limit of Mild Steel. J. SELWYN CASWELL. *Engineering*, Vol. 136, Aug. 11, 1933, pages 154-155. Fatigue tests were made on mild-steel specimens ground and polished in a circumferential direction and on other specimens ground and polished in a longitudinal direction. The following conclusions were drawn as to the effect of surface finish on fatigue limit: (1) stress limits assigned in fatigue tests on specimens ground and polished circumferentially may have only a nominal value, (2) in rotary beam testing of such specimens, the stress range may not be truly alternating, (3) fatigue limits and endurance curves would have greater value if qualified by a reference to the grade of surface finish, (4) there seems to be greater freedom from scratch effect when specimens are ground and polished longitudinally, (5) machine parts subjected to cyclical stress should be ground and polished so that the residual scratches are parallel to the direction of the stresses produced near the surface, (6) the effect of surface finish is greater in parts made of high-C steel or special alloy steels. Endurance curves are given for the specimens tested.
LFMp (9c)

High-Vacuum Spectrograph for Chemical Analysis with X-Rays (Ein Hochvakuumspektrograph für chemische Analyse mit Röntgenstrahlen) E. ALEXANDER. *Zeitschrift für Physik*, Vol. 83, June 28, 1933, pages 512-516. Description of the instrument with 2 dispersion of 8 and 13 cm. radius of film respectively and an exposure angle of 120°.
Ha (9c)

Magnetic Testing (9d)

L. REID, SECTION EDITOR

1 **New Methods of Electric and Magnetic Testing of Welded Seams (Neuerungen auf dem Gebiete der magnetischen und elektrischen Schweissnahtprüfung)** E. FRANKE. *Elektrotechnische Zeitschrift*, Vol. 54, July 6, 1933, pages 659-660. The new magnetic method by Meller uses 3 electromagnets in such combination that the magnetic flux is compelled to pass through the defective place and cannot go around; this makes possible the detection of even very small defects. The new electric test by Ramsauer consists in sending a direct current through the weld and measuring the potential difference between definite distances by a watt meter arrangement. In case of an inhomogeneity in the weld the 2 circuits are not balanced and the instrument is deflected.
Hap (9d)

2 **Magnetic Properties of Thin Metal Layers (Magnetische Eigenschaften dünner Metallschichten)** W. ELENBAAS & W. F. VAN PEYPE. *Zeitschrift für Physik*, Vol. 76, 1932, pages 829-848. Electrolytically prepared layers of Fe and Ni of 0.2-20 μ were investigated with respect to their magnetic behavior. Coercive power and remanence increase with decreasing thickness in Fe. The thin layers of Ni can be magnetized only with difficulty. The magnetic properties are greatly influenced by temperature.
Ha (9d)

Energy Loss Testing of Magnetic Materials Utilizing a Single Strip Specimen. C. DANNATT. *Journal of Scientific Instruments*, Vol. 10, Sept. 1933, pages 276-285. The theory, development and performance of a tester for measuring energy loss in single strip magnetic specimens under alternating magnetization.
RAW (9d)

3 **Magnetic Analysis of Internal Stresses. II. (Zur magnetischen Analyse der inneren Spannungen II.)** M. KERSTEN. *Zeitschrift für Physik*, Vol. 82, May 30, 1933, pages 723-728. The change in the remanence of ferro-magnetic materials caused by tensile or compression stresses is used for the determination of interior stresses. The theory and a formula are developed from experimentally found data.
Ha (9d)

Two Simple Auxiliary Apparatus for the Determination of Magnetic Properties of Sheet Rings (Ueber zwei einfache Hilfsapparaturen für die Bestimmung magnetischer Eigenschaften an Blechringen) H. KUEHLEWEIN. *Zeitschrift für technische Physik*, Vol. 14, Aug. 1933, pages 314-319. Description of the apparatus which records automatically photographs of hysteresis loops, Curie points and other magnetic phenomena. Examples are given.
Ha (9d)

4 **An Apparatus for Magnetic Testing at High Magnetizing Forces.** RAYMOND L. SANFORD & EVERT G. BENNETT. *Bureau of Standards Journal of Research*, Vol. 10, Apr. 1933, pages 567-573. Description of an apparatus suitable for general magnetic testing in the range of values of magnetizing force from 100-1000 oersteds. Specimens of rectangular cross-section from ½"-1½" in width and any thickness up to ¾" can be tested with an accuracy estimated to be within 2%. The apparatus is convenient and simple to operate and does not heat the specimen.
WAT (9d)

Electrodeposition of Metals and Alloys from Formamide Solutions. R. D. BLUE & F. C. MATHERS. *Transactions Electrochemical Society*, Vol. 63, May 1933, pages 231-238. From a solution of Al chloride and ferric chloride in formamide, the authors deposited on Cu and Pt cathodes an alloy of 17.65% Al and balance Fe. Al in the pure state was not deposited. Alloys of Al and Zn, Al and Mn were also deposited in which the Al content was small. Addition of HCl gas to the formamide electrolyte improves the deposits of Cu, Zn, Bi, Ni, Fe and Cr, but interferes with the deposition of Al. Sn, Pb and Cd were also deposited from the formamide solution of the chlorides. Zn, Ni, Cd and Sn were also deposited from formamide solutions of their sulphocyanides.
LCP (9d)

5 **Studies on the Magnetic Method of Revealing the Defects in Work.** K. V. GRIGOROV & M. N. MIKHEEV. *Journal tekhnicheskoj fiziki*, Vol. 2, May 1932, pages 190-199 (In Russian). Sensitivity of magnetic method is tested for an artificial flaw, produced electrolytically on the inner surface of longitudinally cut test bar, and determined as a function of dimensions of the flaw and of the value of magnetizing force. Detection and localization of flaws with area equal to several tenths of a percent of area of test bar is possible. The sensitivity is greatest at saturation. An automatic apparatus is described, suitable for continuous magnetic control of a wire for flaws, the wire being drawn through a magnetizing coil with multiple indicator coil inside; the indicator coil acts through an amplifier on a relay actuating a device for producing paint marks at a constant distance from the flaw.
LI (9d)

6 **More About Magnetic (?) Superhardening.** Correspondence from R. H. HARRINGTON & FREDERICK G. SEFING. *Metal Progress*, Vol. 22, Sept. 1932, pages 48-50. Harrington suggests that it is not certain that the magnetic treatment has been responsible for the differences observed by Herbert and there is lacking a confirmation of his results by other investigations. Sefing points out that there are a number of methods of superhardening steel, such as reheating for some time and passing an electric current which probably effects a result by reason of its heating effect. He also suggests that heat treating strains may be relieved by slight heat with consequent hardening.
WLC (9d)

Spectrography (9e)

7 **Spectrum-Analytical Detection of Minute Quantities: "Searching for Traces" (Spektralanalytische Erfassung kleinster Mengen: "Spurensuche")** W. GERLACH. *Angewandte Chemie*, Vol. 46, Sept. 2, 1933, pages 447-562. The technique of spectrum analysis is described; its advantages, small amounts required, and possibility of taking tests on many places of a specimen; its disadvantages, that the analysis is good only for the place where it is made and influence of impurities on the distinctness of the bands are discussed. Practical applications in the fields of metallurgy and criminology and the investigation of purity of metals are given, and spectrum bands produced under different conditions illustrated.
Ha (9e)

8 **Spectroscopically Pure Light Sources for Photochemical and Spectroscopic Uses (Spektralreine Lichtquellen für photochemische und spektroskopische Zwecke)** H. ALTERTHUM & M. REGER. *Die Chemische Fabrik*, Vol. 6, June 28, 1933, pages 283-285. For photochemical investigation sources producing light bands of very narrow wave length are desirable so that too much light is not wasted through filters. The Cd vapor lamp is similar in principle and construction to the old Na lamp. It operates on 220 volts and 2 amps. It consists of a double glass bulb, for heat insulation, filled with a rare gas and contains some metallic Cd and 2 oxide electrodes. When the lamp is started the gas glows first, then the Cd vapor glows and the gas stops glowing. Cd produces blue, green, and red light, and by suitable filters any of these alone can be obtained. By using quartz bulbs ultraviolet light can be obtained from the Cd lamps. The Tl lamp has somewhat different construction and is used with or without Wratten and other filters. The Zn lamp is made with glass or quartz bulbs and produces blue and red light. Cs and Rb lamps produce pure white light under certain conditions of current, temperature, and vapor pressure. At low vapor pressure Cs light is blue and Rb violet. The K lamp is similar to the Cd lamp. Its light is dark blue. A high pressure Hg lamp is used as an intensive Hg light source. A tabulation gives the wave lengths obtained with various lamps and filters.
CEM (9e)

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*Many authorities state that Mg (a critical component) cannot be determined in diecast alloys, within these limits, by any but spectrographic methods.

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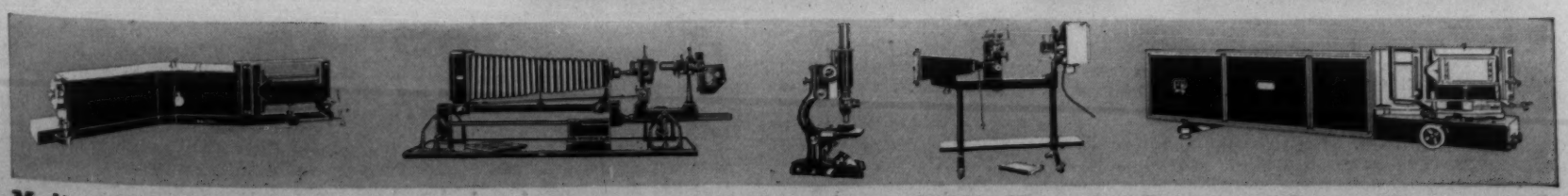

Medium Spectrograph, Large Metallographic Equipment, FSM Microscope, SI Metallographic Equipment, Littrow Spectrograph

METALLOGRAPHY (10)

J. MARSH, SECTION EDITOR

Atlas Metallographicus. H. HANEMANN & A. SCHRADER. Gebrüder Borntraeger, Berlin, 1933. Paper, 7½ x 10¾ inches. Parts 10-14. Price Part 10, 15 RM; Part 11, 13.50 RM; Part 12, 14 RM; Part 13, 14 RM; Part 14, 16 RM. A goodly section of this serial publication is included in these five sections, completing the presentation of micrographs showing characteristic structures of iron and steel. The story is told chiefly by means of Miss Schrader's marvelous micrographs with tabulated information as to composition and heat-treatment of the steel and as to the etching procedure. The descriptive text is extremely brief.

Of particular interest are micrographs illustrating the progress of spheroidization, and of recrystallization of the material under a Brinell impression, as well as those showing nitride needles, slip lines and Lüders lines. The structures of steel in different stages of a tensile test, and that of a severely cold-drawn eutectoid steel showing fractures in cementite particles (and in slag inclusions) are also highly interesting.

The loose-leaf arrangement in folders is not very satisfactory, since there is too much danger of loss and the margins are not sufficient to allow satisfactory binding. Such a nice job of metallography and of reproduction deserves being bound and it is to be hoped that a suitable margin can be allowed in future sections.

Part 14 contains an index to all the section on iron and steel.

H. W. Gillett (10) -B-

Cutting Tools of Fe-Co-W. W. KÖSTER. *Metal Progress*, Vol. 24, Aug. 1933, pages 42-44. Abstract of paper appearing in *Archiv für das Eisenhüttenwesen*. See "The System Iron-Cobalt-Tungsten," *Metals & Alloys*, Vol. 3, Oct. 1932, page MA 294. WLCp (10)

Fibre Structure of Cold-Rolled Iron (Die Faserstruktur des des kaltgewalzten Eisens) B. GARRE & A. WALSDORF. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 212, June 1933, pages 329-330. The structure of Fe cold-rolled below the recrystallization temperature shows for low-C content a lower tensile strength in the direction of the fibers than vertically to this direction. Highly carburized Fe shows the same behavior, while for medium C contents the tensile strength is greater in the direction of the fibers than vertical to it. Hap (10)

Transformation of Austenite Into Martensite and Quenching of Steels : Practical Applications (La Transformation de l'Austénite en Martensite et la Trempe des Aciers : Conséquences Pratiques) A. MICHEL. *Science et Industrie*, Vol. 16, Dec. 1932, pages 514-516. Gives, with theoretical explanation, examples of practical applications for each of his 5 conclusions; especially shows advantages of several successive tempering treatments for increasing hardness of high-speed steels and points out that a single tempering of longer duration cannot replace successive reheatings. FRp (10)

Precipitation from Supersaturated Solid Solutions After Cold Working According to the Thermal Expansion Diagram (Ausscheidung aus übersättigten Mischkristallen nach Kaltverformung im Wärmeausdehnungsdiagramm) FRANZ BOLLENRATH. *Metallwirtschaft*, Vol. 12, Oct. 6, 1933, pages 569-573. Elektron, containing 10.09% Al, 0.40% Mn, balance Mg. Lautal 4.20% Cu, 1.62% Si, balance Al, and Duralumin with 3.67% Cu, 0.48% Mg, balance Al were heated above the solution temperature and quenched in water. Bars of the first two were stretched in a tensile machine 9% and 18% respectively immediately after quenching, and the Duralumin was cold rolled with reductions from 4 to 48%. The bars were then heated in a dilatometer to 500° C. and the results are given in graphs together with the differential quotient curves. Before the precipitation stage is reached a slight increase in thermal expansion indicates a rearrangement of atoms. With increasing amount of cold working the coefficient of expansion at the lower temperatures is decreased and the temperatures of the start of precipitation, the greatest acceleration, the highest speed, and the end of precipitation are all reduced. With increasing cold work the greatest acceleration of precipitation is increased and the temperature range of precipitation is narrowed. The effect is considerable with small amounts of deformation, but does not increase much after a certain point. In solid solutions supersaturated with two constituents, the two precipitate in different temperature ranges without much influence on another. The precipitations at low temperatures changed more than those at higher temperatures. The solution of both constituents takes place at the same temperature. Micrographs of Duralumin after being cold worked 11% and reheated to various temperatures are given. 14 references. CEM (10)

Structure of Iron-Nickel Alloys (Sur la structure des alliages fernickel) W. BRONIEWSKI & J. SMOLINSKI. *Comptes Rendus*, Vol. 196, June 12, 1933, pages 1793-1796. Using electrolytic iron and nickel, the authors prepared a series of alloys melted in vacuum in a high-frequency furnace and subsequently drew them into 5-mm. silica tubes. Samples thus prepared were homogenized by annealing at 950° C. in vacuum for 100 hr., followed by slow cooling to room temperature in 24 hr. All alloys showed a single phase except those containing between 28 and 30% of nickel, which gave evidence of 2 phases. A number of parameters were investigated, and the results are shown in a figure. The most important inversions in the property curves occur between 25 and 35% of nickel and seem to be connected with the lowering of the transformation points of iron to room temperature rather than with definite compounds. The presence of the compound $FeNi_2$ seems to be definitely confirmed. Its existence being admitted, the structure of Fe-Ni alloys at room temperature should be interpreted as follows: up to 28% Ni, solid solution of $FeNi_2$ in Fe; from 28 to 32% Ni, mixture of two limited solid solutions; from 32 to 67.8% Ni, solid solution of Fe in $FeNi_2$; from 67.8 to 100% Ni, solid solution of Fe in $FeNi_2$. The inversions noted in the neighborhood of Fe_2Ni can be explained by the fact that this composition corresponds approximately to the limit of the solid solution of Fe in the compound $FeNi_2$. OWE (10)

The α-γ Transformation in Ternary Alloys of Iron (Die α-γ-Umwandlung in den Dreistoffsystemen des Eisens) W. KÖSTER & W. TONN. *Archiv für das Eisenhüttenwesen*, Vol. 7, Sept. 1933, pages 193-200. The conformation of the $\alpha+\gamma$ fields in the ternary alloys of iron is depicted by models. These are divided into three basic groups. In group I, both of the alloying elements with Fe broaden the γ field as in the Fe-Co-Ni and Fe-Co-Mn alloys. In group II both of the alloying elements give closed γ loops as in the Fe-Al-Si and Fe-Cr-Mo alloys. In group III one of the alloying elements broadens the γ field and the other gives a closed γ loop as in the Fe-C-Si, Fe-C-P, and Fe-Ni-Cr alloys. On these basic forms the other possibilities, including the occurrence of limited solubility fields and the appearance of a third crystal form, may be constructed. The various combinations are illustrated by models with sectional views for greater clarity. The models depict not only the forms of all the ternary alloys which have thus far been studied, but also indicate possible forms which are as yet unknown. 24 references. SE (10)

Iron-Nickel-Aluminum System (Das System Eisen-Nickel-Aluminium) W. KÖSTER. *Archiv für das Eisenhüttenwesen*, Vol. 7, Oct. 1933, pages 257-262. Views are shown of the solid model of the Fe-Ni-Al system, as determined up to contents of 30% Al. Various sectional views of the system at Ni contents of 10-80%, and at Al contents of 5-12.5%, are also shown as well as micrographs illustrating the needles in the various precipitation hardening alloys of the system. A compound, NiAl, is formed which, however, forms a continuous series of solid solutions with α-iron, so that in the solid state, only the α and γ phases appear. There is a series of alloys in which the γ phase has a high solubility in α at high temperatures and a considerably lower solubility at room temperatures. The α phase is ferromagnetic up to about 20% Al and 70% Ni. SE (10)

Iron-Cobalt-Aluminum System (Das System Eisen-Kobalt-Aluminium) W. KÖSTER. *Archiv für das Eisenhüttenwesen*, Vol. 7, Oct. 1933, pages 263-264. Views of the solid model of the Fe-Co-Al system are shown and this system compared to the Fe-Ni-Al system. The two are very similar. SE (10)

1 **The Constitution of the Silver-rich Aluminum-silver Alloys.** N. AGEEW & D. SHOYKET. *Institute of Metals, Advance Copy* No. 636, Sept. 1933, 8 pages. Alloys containing up to 10% Al were investigated by X-ray and microscopic methods. They were made from C.P. Ag and Al containing 0.08% Fe, 0.15% Si, and 0.16% Cu. JLG (10)

Some Characteristics of the Microstructure of Cold-Drawn Brass Tubes. JAMES FOX. *Mechanical World & Engineering Record*, Vol. 93, July 28, 1933, pages 722-723. According to the amount of cold work imposed on the tubes the following characteristics were observed: (1) The non-axial nature of the crystals. (2) The cross-hatched appearance of many of the fragmented crystals. (3) The single or multiple fractures that had occurred across some of the crystals, the fragments thus formed being embedded in relatively thick, amorphous metal. These three characteristics—compared by means of photomicrographs—become more pronounced as the percentage reduction increases. The hatched lines ("slip bands") across a crystal are similar to those observed when a piece of metal is deformed by external force. The lines in any one crystal are always inclined to similar lines in an adjacent crystal. Fracture planes never intersect in any one crystal. No further "slip" takes place on any fractured surface once fracture is complete. The material which cements the fragments together is apparently stronger than the crystals themselves. Kz (10)

2

3 **The Influence of Carbon on Ten Per Cent Manganese—Iron Alloys.** JOHN F. ECKEL. *Doctor's Thesis*, 163 pages. 1932. *Carnegie Institute of Technology*, Pittsburgh. A comprehensive metallographic study. Includes 133 figures. 1. C exerts a stabilizing influence on the gamma phase in the 10% Mn-Fe alloys by lowering the temperature of the gamma to alpha transformation range. This transformation is entirely suppressed in the higher C alloys at least to —192° C. unless the carbides are first precipitated by a suitable heat treatment. 2. The epsilon phase may form in all of the alloys with a C content as high as 1.37%. High C alloys (0.40-1.4% C) require a heat treatment resulting in the precipitation of most of the carbides in order to form the epsilon phase. 3. The solution of C atoms in the face centered cubic lattice of the gamma phase produces an expansion of that lattice. 4. There appear to be 2 distinct temperature ranges in which the rate of decomposition of the gamma phase may occur at appreciable rates. First, near 500° C. the decomposition of the gamma phase seems to follow a reaction of the 1st order, and second, below 165° C. the decomposition of the gamma phase also occurs at an appreciable rate. C increases the rate of decomposition in the 500° C. range. The temperature range of decomposition at about 165° C. is lowered by successive additions of C. 64 references. CWS (10)

4

Effect of Hydrogen on the A_3 and A_1 Transformations in Iron (Einfluss von Wasserstoff auf die A_3- und A_1-Umwandlung des Eisens) H. ESSER & H. CORNELIUS. *Stahl und Eisen*, Vol. 53, Aug. 24, 1933, pages 885-886. A doubling of the A_3 and A_1 points similar to that observed by Harrington and Wood in Fe-C alloys, was found on heating in H_2. After heating in a high vacuum, only single arrest points were observed. Harrington and Woods' double points were therefore attributed to H_2 in their specimens. SE (10)

5 **The Crystal Structure of the Rhombic Chromium Carbide. (Den rombiska kromkarbidens kristallbyggnad.)** KJELL HELLBOM & A. WESTGREN. *Svensk Kemisk Tidskrift*, Vol. 45, 1933, pages 141-150. Westgren and Phragmén have shown that Cr_3C_2 crystallizes in the rhombic system, that the dimensions of the unit cell are a = 11.46, b = 5.52, and c = 2.821 A.U., and that its number of atoms is 20. Using these X-ray findings and extending them by new powder photograms and oscillating crystal photograms taken with Cu-K-radiation, the authors have been able to determine that the space group of the carbide is V_h^{16} and that the 12 Cr atoms of the unit cell are distributed in three 4-digit positions with the following coordinates:

6 u, v, ¼; u, v, ¾; u + ½, v + ½, ¼; u + ½, v + ½, ¾;

defined by the parameter pairs: $u_1 = 0.406$, $v_1 = 0.031$; $u_2 = -0.230$, $v_2 = 0.175$; $u_3 = -0.070$, $v_3 = -0.150$, which may be considered exact within ± 0.01. The C atoms are found in two 4-digit positions, defined by the parameter pair: $u_4 = 0.109$, $v_4 = -0.100$; $u_5 = -0.057$, $v_5 = 0.217$. If they are oriented in this manner, they would build folded C chains traversing the crystal in the direction of the c-axis. The crystal should then be built up of parallel giant molecules of the chain type. BHS (10)

Solubility of Copper in Zinc (Die Löslichkeit von Kupfer in Zink) M. HANSEN & W. STENZEL. *Metallwirtschaft*, Vol. 12, Sept. 22, 1933, pages 539-542.

7 Samples were made from 99.99% pure Zn and electrolytic Cu and contained from 0.58 to 4.03 atomic % Cu. X-ray precision measurements were made on a series quenched from 395° C. Up to 2.08% Cu, only the η phase appeared, with 3.10 and 4.15 Cu, $\eta + \epsilon$. With rising Cu content the η diffraction lines are shifted. In the 3 and 4% Cu alloys there is no change in the η lines, but additional (ϵ) lines appear. The 3 and 4% Cu alloys were also drawn at various temperatures and examined. The solubility of Cu in Zn at 100°-424° C. is shown diagrammatically. It is higher than it was formerly thought to be. The peritectic point, 424° C., is at 2.73 atomic % or 2.68% by weight. The solubility at 395° is 2.43 atomic %. The calculated volume decrease of the peritectic alloy against pure Zn is 1.4% or sp.gr. 7.236. Reheating should theoretically decrease this 0.005%. Actual tests showed a decrease of 0.008 and 0.007. Samples quenched at 415° and drawn various lengths of time at 240°, 350°, 295°, and 200° were examined

8 microscopically. The results agreed with the X-ray examinations. 17 references. CEM (10)

A Graphical Method for Converting the Weight Percentage Compositions of Ternary Systems into Atomic or Molecular Percentages. WILLIAM HUME-ROTHERY. *Institute of Metals, Advance Copy* No. 643, Sept. 1933, 5 pages. Describes a method for use with 60° ruled paper which gives an accuracy of about 0.5%. JLG (10)

9 **Determination of Particle Size of Grinding Powders and their Fractionation by Continuous Elutriation. (Bestamning av kornstorlek hos slipmedel och deras fraktionering genom kontinuerlig stromslamning.)** C. BENEDICKS & P. E. WRETBLAD. *Jernkontorets Annaler*, Vol. 117, Aug. 1933, pages 419-441. Sedimentation methods for the fractionation of American Optical Company grinding powders failed to give results comparable with micro-measurements. Two causes were found to explain this: First the particles seemed to drop in swarms without classification, and, second, convection currents caused upward flow near the wall of the sedimentation tube and downward flow in the middle. A tube was constructed in which the liquid was given a temperature gradient so that a continuous increase of density downward was effected to prevent irregular currents. The particles were kept in suspension by an air-free 0.008 molar $Na_4P_2O_7$ solution. By taking account of the variation in density and viscosity down the tube, Stokes's formula may be applied directly, and experiments show that the fractionation corresponds closely to micro-measurements. Samples of 1 mg. suffice for a determination. Sedimentation to par-

10 ticles of 1 μ and 2μ requires 10 and 2 days, respectively. In order to prepare uniform powders for dry polishing Fe samples, a continuous apparatus was devised in which liquid and powder were fed concurrently through a series of chambers of increasing diameter. This apparatus was found capable of fractionating 200 g. in 10 days, and producing a uniform powder of 2-4μ and 3-6μ without any coarse particles. HCD (10)

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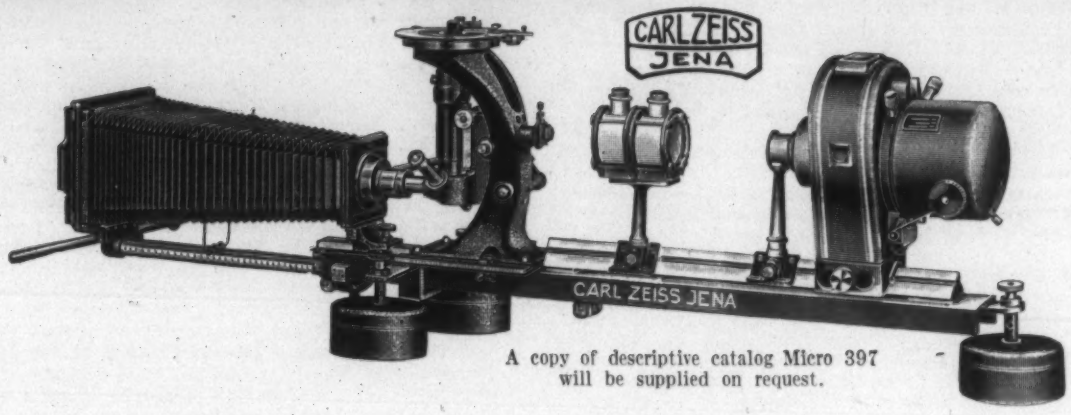

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Study of Constitution (of Alloys) by Magnetic Methods. Part I. Dia- and Paramagnetic Measurements (Konstitutionsforschung mit magnetischen Verfahren. Teil I. Dia- und paramagnetische Messungen) A. Kussmann. *Zeitschrift für Metallkunde*, Vol. 25, Oct. 1933, pages 259-266. A review, under the following headings: fundamental quantities, general behavior (of metals), methods of measurement, relationship with constitution (of alloys), kinetics of transformation, lattice distortion, tests for the presence of Fe, solubility relationships, aging, influence of cold deformation. RFM (10)

Supraconductivity of Alloys from the Viewpoint of Phase Theory (Die Supraleitung der Legierungen von phasentheoretischen Standpunkt) C. Benedicks. *Zeitschrift für Metallkunde*, Vol. 25, Sept. 1933, pages 197-202. A discussion built largely upon the work of Meissner, Franz, and Westerhoff (*Annalen der Physik*, Series 5, Vol. 13, 1932, page 505). The critical temperature at which supra-conductivity obtains in alloys on cooling is plotted theoretically against composition for Roozeboom's five types of t-x diagrams. The effect of heterogeneity upon the critical temperature is derived from the extreme concentrations which may occur on quickly freezing a solid solution alloy; this effect gives a range of temperatures at which the critical temperature may occur. Within a range of solid solutions the critical temperature varies with composition on a smooth curve; across heterogeneous fields it is stepped, the position of the step depending upon the mode of distribution of the constituents in the alloy. Data on the critical temperatures in the systems In-Pb, Hg-Pb, Bi-Pb, Sn-Tl, In-Tl, and Pb-Tl (in which the five types of t-x diagrams are represented) are given and found to conform to the general rules laid down. Thus solid solutions can show supra-conductivity. Both solid solutions and intermetallic compounds can show a higher critical temperature (more easily supra-conducting) than pure metals. These observations indicate that electrons may readily pass from one atom to an atom of a different kind. RFM (10)

Dilatometric Study of Stainless Irons and Steels. H. O. Dahlke & W. S. Newton. *Masters' Thesis*, 26 pages, 1932, Carnegie Institute of Technology, Pittsburgh. A study of the transformation points in steel containing 13-17% Cr and 0.10-0.90% C with and without small additions of Cu, Ni, Mn, and Mo. Changes in volume observed over temperatures ranging from 900° C. to liquid N by means of a dilatometer. Low temperature has no effect on the transformations. Where there is evidence of a split transformation, holding at the temperature for sufficient time where the split first appears will cause the complete transformation to take place. Effect of added elements: C lowers the transformation points, tends to produce a split transformation and increases the size of the gamma loop. Cr raises the transformation points and decreases the size of the gamma loop. Ni lowers the transformation points on heating and cooling, increases the size of the loop, and counteracts the tendency of C in producing the split. Cu behaves the same as Ni but not so markedly. S has no noticeable effect on the transformation temperatures. Mo apparently has the same effect as Ni. CWS (10)

X-ray Studies on the Nickel-Chromium System. Eric R. Jette, V. H. Nordstrom, Bernard Queneau & Frank Foote. *Metals Technology*, Jan. 1934, Technical Publication No. 522, 11 pages. Previous work on the Ni-Cr system is reviewed. Alloys were prepared from electrolytic Ni and electrolytic Cr. They were melted in a vacuum. Powders were prepared by filing or by grinding. The powders were annealed at different temperatures in a vacuum, quenched, and patterns obtained with a Phragmén camera. No structures other than those of Cr, Ni, and, occasionally, the rhombohedral structure of Cr_2O_3 were found. The limits of solid solubility at each end of the system were determined from lattice parameters. At 400° C. and below Cr held 1% Ni in solution, and at 1100° C. 10%. The curve for the solid solubility of Cr in Ni was a straight line running from 31% Cr at 500° C. to 52% Cr at 1100° C. This line is not compatible with the solidus-liquidus portion of the diagram determined by other workers unless retrograde solubility exists at temperatures above 1100° C. 17 references. JLG (10)

Etching Procedure for the Metallographic Examination of the Alloys of the Platinum Metals (Ätzverfahren für metallographische Untersuchungen von Legierungen der Platinmetalle) F. Beck. *Metallwirtschaft*, Vol. 12, Nov. 3, 1933, pages 636-637. Ordinary etching solutions and fused salt mixtures are not satisfactory for Re-Pt, Re-Rh, and Re-Ir alloys. Good results are obtained by pouring molten NaCl into a small graphite crucible containing a Pt triangle which serves as a cathode. The NaCl is kept molten at about 860° C. by means of a gas burner and the specimen to be etched, which is attached to a Pt wire, is immersed in the crucible and forms the anode. A current of 3 amps./cm.² at 2.5 volts is passed through the bath for 5 to 46 seconds, depending on the composition of the alloy. The specimen is then dipped in distilled water, dried in alcohol, and is ready for examination. CEM (10)

Principles of Quantitative X-ray Analysis of the Concentration of Metal Phases in an Alloy or Mixture (Über die Grundlagen einer quantitativen Röntgenanalyse der Konzentration von Metallphasen in einer Legierung oder Mischung) R. Glocker. *Metallwirtschaft*, Vol. 12, Oct. 20, 1933, pages 599-602. No general rules can be set down for X-ray analysis of metal phases, such as the rules for X-ray spectrum analysis. For each individual case, equations must be deduced and several correction factors determined. The most difficult to determine are the temperature and the extinction factors. 28 references. CEM (10)

X-Ray Investigations by Long-wave Radiation (Röntgenkristallographische Untersuchungen mit langwelliger Strahlung) Gunnar Hägg. *Zeitschrift für Kristallographie*, Vol. 86, Sept. 1933, pages 246-252. In spite of the smaller number of reflections, long wave X-rays guarantee safer indexing and are particularly suitable for powder experiments. Hägg devised a camera for soft $Ca_{K\alpha}$ radiation (3.35 A.U.). The delicate Ca anticathode can be charged with 5 mA. and 35 kV., yielding pictures in about 12 hours. The Si_K radiation is unsuitable due to fargoing absorption by the Al window. An Al foil of 10 μ thickness absorbs about 70% of the original Ca_K radiation, while the Al_K radiation is absorbed 60%. Load: 8 mA. and 35 kV. Mg anticathodes can be prepared easily. About 75% of their radiation is absorbed by a 10μ Al foil. Ca_K radiation successfully resolved the lines secured on a complicated intermediary phase in the Fe-Cr system at 50 atomic % and on a monoclinic phase in the Fe-Se system, when the Cr_K radiation failed. On account of their moderate penetration power, long wave X-rays can be advantageously applied to the study of surface phenomena. EF (10)

Crystal Orientations Developed by Progressive Cold Rolling of an Alloyed Zinc. M. L. Fuller & Gerald Edmunds. *Metals Technology*, Jan. 1934, Technical Publication No. 524, 8 pages. A Zn-rich alloy containing 1% Cu and 0.01% Mg was used. The only effective difference between this material and pure Zn, for the purpose in hand, was the higher recrystallization temperature of the alloy. Annealed sheet and sheet rolled to reductions of 30, 50, and 80% were used. Orientations determined were those midway between surface and center. Orientations of the basal planes were determined and plotted as pole figures. These pole figures were correlated with the deformation by slip and twinning observed in Zn crystals by other workers and to the conditions of deformation. A new type of preferred orientation for Zn was noted; it was the orientation of the basal plane perpendicular to the direction of rolling. 13 references. JLG (10)

The Lattice Parameters of Pure Iron and Iron-Carbon Alloys at Temperatures up to 1100°C (Die Gitterkonstanten von reinem Eisen und Eisen-Kohlenstoff-Legierungen bei Temperaturen bis 1100°) H. Esser & G. Müller. *Archiv für das Eisenhüttenwesen*, Vol. 7, Oct. 1933, pages 265-268. A vacuum X-ray apparatus was built in which 5 exposures of a wire specimen could be made at various temperatures on one film. The lattice parameters of electrolytic and carbonyl iron showed discontinuities at the magnetic transformation point. In the Fe-C alloys the graph for the relation between lattice parameter and C content in the γ-temperature region was not linear, but slightly curved. SE (10)

Significance of the Curie Points in Solid Solutions (Sur la Signification des Points de Curie dans les Solutions Solides) M. R. Forrer. *Revue Générale de l'Electricité*, Vol. 33, Apr. 22, 1933, pages 515-516. The Curie point of ferromagnetic substances is brought into relation with the electron arrangement by a theory which does not assume, as formerly, a definite position of the atoms but simply a statistical distribution, as met with actually in most alloys of cubic face-centered crystal lattice. Ha (10)

Structure and Gas Content of Nickel Layers Prepared by Cathodic Atomization (Ueber die Struktur und den Gasgehalt von Nickelschichten, die durch kathodische Zerstäubung hergestellt sind) W. Buessem & Friedr. Gross. *Zeitschrift für Physik*, Vol. 86, Oct. 17, 1933, pages 135-136. Cathodic atomization of Ni produces different crystal structures dependent on the atmosphere in which it takes place; for instance, hexagonal I or cubic in H_2 or Ne + He; tetragonal, hexagonal II, or cubic in Ne. Influence of temperature and purity of gases is discussed. Ha (10)

Relation between Increase of Strength and Ability of Recrystallization in Plastic Deformation of Metals. IV. Recrystallization of Al-Monocrystals (Zur Frage des Zusammenhanges zwischen Verfestigung und Rekristallisations vermögen bei plastischer Deformation von Metallen. IV. Rekristallisation von Aluminumeinkristallen) W. G. Burgers & J. J. A. Ploos van Amstel. *Zeitschrift für Physik*, Vol. 81, No. 1/2, 1933, pages 43-65. Former investigations on recrystallization are reviewed; it was found that the germs of new crystals originate in the curved part of the sliding lamellae formed by the fact that actual sliding takes place only over restricted areas of the sliding planes. Recrystallization experiments with Al monocrystals seem to indicate that the capacity for recrystallization, as measured by the number of forming crystallites, is the smaller (for the same heat treatment) the more sliding planes were affected by the deformation. This observation used to explain certain discrepancies in the previous investigations. Diagrams try to illustrate the mechanical process in recrystallization. 51 references. Ha (10)

Structure and Origin of the Copper-Cuprous Oxide Eutectic. L. W. Eastwood. *American Institute Mining & Metallurgical Engineers, Contribution* No. 59, Oct. 1933, 8 pages. The Cu-Cu_2O eutectic is carefully described. It is of the eutectic-colony type described by Portevin. The Cu_2O particles occur as both spheroids and rods. Several colonies may be found in the same eutectic grain. 4 references. JLG (10)

On the Grain Refinement of Various Alloys by Peritectic Reactions J. Asato. *Kinzoku no Kenkyu*, Vol. 10, Dec. 1933, pages 488 to 503 (In Japanese). It was shown, in the former paper, that in the copper-rich alloys, the crystal grains became very fine when iron or cobalt were added up to their peritectic points. In the present paper, it is shown that the similar phenomenon also takes place in various alloys such as Sn-Cu, Si-Cu, Zn-Cu, Zn-Ag, Cd-Ag, Sb-Sn and Al-Ni systems, all of which have peritectic reactions. KT (10)

Formation of Pearlite. Owen W. Ellis. *Iron & Coal Trades Review*, Vol. 127, Dec. 1, 1933, page 829. Paper read before the Detroit convention of American Society for Steel Treating is summarized. Ha (10)

Metal Microscopy at High Temperatures. The Fe-C Diagram and the Solubility of O_2 in Solid Iron. Hans Esser & Heinz Cornelius. *Metals & Alloys*, Vol. 4, Aug. 1933, pages 119-122. Describe apparatus for microscopic examination of metals at elevated temperatures. 13 references. WLC (10)

Ferrites. Second Communication: Group of Alkaline, Alkaline-Earth and Lead Ferrites (Über Ferrite. 2. Mitteilung: Gruppe der Alkali-, Erdalkali und Bleiferrite) S. Hilpert & A. Lindow. *Zeitschrift für physikalische Chemie*, Sect. B, Vol. 22, Sept. 1933, pages 395-405. Continuation of previous work. X-ray investigation of ferrites of K, Rb, Cs, Ca, Sr, Ba, and Pb revealed structural analogy among one another but divergencies from the spinell-ferrite type. EF (10)

Electric Conductivity and Constitutional Diagram of Binary Alloys. 8. The System Lithium-Zinc (Elektrische Leitfähigkeit und Zustandsdiagramm bei binären Legierungen. 8. Das System Lithium-Zink) G. Grube & H. Vosskuehler. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 215, Nov. 17, 1933, pages 211-224. A thermal analysis of Zn-Li alloys was made by taking resistance-temperature curves of the solid alloys. Five series of solid solutions exist which are separated by heterogeneous fields. The existence of the compound Li_2Zn_3 was confirmed; it crystallizes directly from the melt and changes in cooling at 174°C. to $LiZn_2$. The complete Li-Zn diagram was developed. 8 references. Ha (10)

Powder-Method Divergencies from Bragg's Law (Abweichungen von der Braggschen Beziehung bei der Pulvermethode) Gunnar Hägg & Gösta Phragmén. *Zeitschrift für Kristallographie*, Vol. 86, Sept. 1933, pages 306-308. The Bragg formula holds true only for symmetric reflections which do not prevail in powder photographs. The problem of absorption and development of certain crystal-surface types (needles, plates, etc.) is discussed. Both phenomena result in a deviation from the ideal Bragg rule. These adverse effects on the diffraction of X-rays in the Debye-Scherrer-Hull method are, however, of minor practical significance in most cases, but should be accounted for in high precision calibration measurements. EF (10)

Are Liquid Sodium Amalgams Colloidal? A Discussion of the Paper of Paranype and Joshi. Henry E. Bent. *Journal of Physical Chemistry*, Vol. 37, Apr. 1933, pages 431-436. Contrary to the conclusions of Paranype & Joshi (*Journal of Physical Chemistry*, Vol. 36, Oct. 1932, pages 2474-24) there is no proof that the properties of pure sodium amalgams are determined by the method of preparation. The hypothesis that sodium amalgams are colloidal rests upon certain properties which are common to the amalgams and to certain colloidal solutions. Since these properties can be accounted for in other ways, there is no proof at present that sodium amalgams are colloidal. The following facts either prove or constitute strong evidence that sodium amalgams are true solutions. (a) The freezing-point depression of Hg in dilute amalgams is calculated for an ideal solution. (b) The vapor pressure lowering is that calculated for an ideal solution. In more concentrated amalgams the lowering is greater than is calculated for an ideal solution. A colloidal solution should show a smaller lowering of the vapor pressure. EF (10)

Ternary Alloys. E. Gregory. *Metal Industry*, London, Vol. 43, Sept. 29, 1933, pages 319-322; Oct. 1933, pages 349-352; Oct. 13, 1933, pages 371-374; Oct. 20, 1933, pages 398-402. The representation of physical properties of 3-component systems by the thermal equilibrium diagram is explained for ferrous and non-ferrous metals. For each of the 3 cases: 1. the 3 metals are completely soluble in all proportions in the solid state, 2. the 3 metals are completely insoluble in the solid state, and 3. the 3 solid metals are soluble to a limited degree only, the diagrams are developed and photomicrographs showing the metallurgical features reproduced. Special reference is made to high-speed steel alloys. Ha (10)

X-ray Analysis of Fe-Al Alloys. The 2nd Report. A. Osawa. *Kinzoku no Kenkyu*, Vol. 10, Oct. 1933, pages 432 to 445. (In Japanese) X-ray analysis was carried out for the whole series of alloys. The X-ray methods used are the Laue-, rotation-, and powder-methods. The phases existing at room temperature are α-iron, $FeAl_2$, Fe_2Al_5 and $FeAl_3$. $(FeAl)_n$ (57% Fe) was obtained by severe quenching from above 1080°C. in water. The parameter of α-solid solution increases from 2.854 A.U. of iron to 2.891 A.U. at 46.7 atomic percent of Al. No deformation structure such as Fe_3Al and FeAl as Bradley said were found in α-solid solution. $(FeAl)_n$ has a parameter of 5.980 A.U. and has 16 atoms per unit cell. $FeAl_2$ crystalises rhombohedrally and contains 18 atoms per unit cell. The parameter is: a = 6.314 A.U., α = 87° 24′ 28″. Fe_2Al_5 belongs to monocline system and contains 56 atooms per unit cell. The parameters are: a = 9.910 A.U., b = 10.811 A.U., c = 8.824 A.U., β 124° 59′ 53″; a : b : c = 0.91665 : 1 : 0.81619. $FeAl_2$ belongs to rhombic system and contains 104 atoms per unit cell. The parameters are: a = 15.804 A.U., b = 11.870 A.U., c = 8.088 A.U.; a : b : c = 1.3314 : 1 : 0.681383. KT (10)

An X-ray Study of the Gold-iron Alloys. Eric R. Jette, Willard L. Bruner & Frank Foote. *Metals Technology*, Jan. 1934, Technical Publication No. 526, 6 pages. Previous work on the Au-Fe system is reviewed. Alloys were prepared by melting pure Au and electrolytic Fe in a vacuum. X-ray diffraction patterns of powders annealed at different temperatures permitted the determination of the solubility of Fe in gold at temperatures below the γ-α transformation of Fe. No intermediate phase was found. The solubility of Fe in Au was 3.9% at 333° C. and 17% at 724° C. The solid solubility of Au in Fe could not be determined precisely, but it was approximately 2% at 724° C. Solutions of Au containing from 10 to 15% Fe are ferromagnetic. Au-rich alloys respond to a precipitation-hardening treatment. 3 references. JLG (10)

Metallurgical Investigation of Mining Equipment. J. H. Andrew. *Iron & Coal Trades Review*, Vol. 127, Aug. 18, 1933, pages 235-236. Couplings, drawbars, lashing chains and other material used in mining operations were investigated as to their safety and metallurgical qualities. The predominant causes of failures are associated with composite material and inclusions, welding and surface hardening due to abrasion. Particular attention must be directed toward the growth of strain hardness in service and the undesirable crystal growth caused by repeated annealing at certain temperatures. Use of a low-C mild steel containing 1.5% Mn is preferable to the use of wrought iron and mild steel for haulage gear. Hap (10)

The Metaphot, a New Metallographic Apparatus (Das Metaphot, ein neues metallographisches Gerät) K. Albrecht. *Die Giesserei*, Vol. 20, Oct. 27, 1933, pages 488-489. A camera for viewing and photographing metallurgical specimens, not in the usual form of the bench but similar to the Graflex type camera, offering a simpler and cheaper apparatus for many routine purposes. Hap (10)

Drawing of Quenched Carburized Steels (Etude du revenue des aciers cémentés trempés) Marcel Chaussain. *Revue de Métallurgie*, Vol. 30, Aug. 1933, pages 349-361. Plain C, Ni, and Ni-Cr steels were carburized, quenched, and drawn. Rockwell hardness and microstructures are given. JDGp (10)

Formation of Columnar Crystals in Steel Sheets after Normalizing. F. Kinsky. *Iron & Coal Trades Review*, Vol. 126, June 9, 1933, page 894; *Sheet Metal Industries*, Vol. 7, July 1933, pages 139-143. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 312. Ha+AWMp (10)

Contribution to the Knowledge of the Salt Lattice (Salzgitter) Iron Ores (Ein Beitrag zur Kenntnis der Salzgitter Eisenerze) J. Klaerding. *Zeitschrift für Elektrochemie*, Vol. 39, Mar. 1933, pages 140-143. These particular German deposits of a composition of 35-41% Fe, 17-32% SiO_2, 7-9% Al_2O_3, 4-9% $CaCO_3$, and 0-1.0% P are difficult to reduce with other ores; reduction curves were taken at 900° C.; greatly differing yields were obtained, depending on grain size and distribution of oxides in the ore. Ha (10)

Ultramicroscopic Differences between the Cast and Recrystallized States of Metals. (Submikroskopische Unterschiede zwischen Guss- und Rekristallizationszustand von Metallen.) U. Dehlinger. *Physikalische Zeitschrift*, Vol. 34, Nov. 15, 1933, pages 836-838. X-ray investigation of changes in internal structure of metals in the solid state showed clearly that the rate of transformation is almost invariably different for single crystals than for drawn and recrystallized metals. RRS (10)

Diffusion of the Ni-Cu System. C. Matano. *Memoirs College of Science, Kyoto Imperial University*, Vol. 16, July 1933, pages 249-259. Diffusion of Ni-Cu system, such as Cu-plated Ni, Ni-plated Cu, and alternate layers of electro-deposited Ni and Cu heated at 500°, 650°, 900° C. for various time intervals, was studied by X-ray method. It is concluded that in a not wide range of concentrations, the value of the coefficient of diffusion can not be constant, but varies from 10^{-7} to 10^{-9} cm.^{2}/day, or more widely at 500° C. HN (10)

The Ternary System MnO-SiO_2-Al_2O_3. D. L. McBride. *Master's Thesis*, 24 pages, 1932. Carnegie Institute of Technology, Pittsburgh. Investigation of parts of the ternary slag system not covered by M. K. Smith. All slags were studied for apparent crystallinity using a polarizing microscope. Representative slags were annealed at various temperatures. Some were examined by the X-ray. A tentative equilibrium diagram of the complete ternary system was constructed. CWS (10)

Electron Emission of Thin Metal Layers in X-Rays (Elektronenemission dünner Metallschichten in Röntgenstrahlen) Joseph Klein. *Zeitschrift für Physik*, Vol. 81, No. 1/2, 1933, pages 101-120. Electron emission of thin metal layers was studied as a function of the thickness of the layer and the frequency of the incident X-rays. By using monochromatic X-rays, the true absorption coefficient of metals can be determined; the coefficient is proportional to the wave length in the range between $\lambda_K < \lambda << \lambda_L$; the photo-emission coefficient is proportional to λ^2. The theory of the calculation is derived. Ha (10)

Röntgenographic Investigations of Solid-Solution System Au-Ag and Investigations of its Susceptibility to Attack by Nitric Acid (Röntgenographische Untersuchungen des Mischkristallsystems Gold-Silber und Untersuchungen über seine Angreifbarkeit durch Salpetersäure) M. Le Blanc & W. Erler. *Annalen der Physik*, Series 5, Vol. 16, Feb. 1933, pages 321-335. Crystals of a solid solution of Au-Ag are attacked by HNO_3 of 1.32 sp.gr. which does not attack pure Au, if there is an Ag content of 48%; from there to 62% Ag the solubility increases and is complete at this percentage. X-ray experiments confirm that alloys of Au-Ag form a continuous series of solid solutions. Ha (10)

X-Ray Analysis of Metals and Alloys John Iball. *Metal Industry*, London, Vol. 43, Aug. 11, 1933, pages 121-123. The process of analyzing metals and alloys by examining their type of structure and by precision measurements of the size of the unit cell is explained and a precision camera is described for taking photographs with X-rays and determining from these the atomic arrangement. Ha (10)

Transformation of Solid Metal Phases. V. Calculation of Kinetic Curves in the System Au-Cu (Ueber Umwandlungen von festen Metallphasen V. Berechnung kinetischer Kurven im System Au-Cu) U. Dehlinger. *Zeitschrift für Physik*, Vol. 83, July 8, 1933, pages 832-842. Mathematic derivation of the differential equations for the transformations irregular ⟶ regular AuCu and $AuCu_3$ and comparison with experimental measurements. 15 references. Ha (10)

Affinity of Metals for Sulphur. III. Heats of Fusion and Formation of Sulphides of Arsenic and the Compounds $As_2O_3 \cdot As_2O_5$ and $As_2O_3 \cdot SO_3$ (Die Affinität von Metallen zu Schwefel. III. Verbrennungs-und Bildungswärmen der Sulfide von Arsen und der Verbindungen $As_2O_3 \cdot As_2O_5$ und $As_2O_3 \cdot SO_3$.) E. V. Britzke, A. F. Kapustinsky, & L. G. Tschenzowa. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 213, July 7, 1933, pages 58-70. The equilibrium $ZnS + 2HCl \rightleftharpoons H_2S + ZnCl_2$ was determined and from it the dissociation pressure of ZnS and affinity of Zn for S calculated. In a similar manner, $MnCl_2 + H_2S \rightleftharpoons MnS + 2HCl$ was measured and the affinity of Mn for S determined in the temperature range from 407-1100° C. Ha (10)

Diffusion in Solid State in the Metallic Pairs Au-Ni, Au-Pd, and Au-Pt (Die Diffusion im festen Zustand bei den Metallpaaren Gold-Nickel, Gold-Palladium und Gold-Platin) A. Jedele. *Zeitschrift für Elektrochemie*, Vol. 39, Aug. 1933, pages 691-695. Diffusion in solid state was measured on a cylindrical rod of one metal which was electrolytically coated with another; thin layers of 0.05 mm. were turned off and analyzed to obtain the diffusion in both directions. The diffusion velocity is different in each metal system and is greater the less the diffusion temperature departs from the solidification temperature of the alloy produced by diffusion. The diffusion velocity of Au into Pt is smaller than that of Pt into Au; it was measured at 900° C. as between 0.1 to 0.5 x 10^{-5} cm.^{2}/day, for Au-Pd as 0.2-2.0 x 10^{-5} cm.^{2}/day and for Au-Ni as 0.5-5 x 10^{-5} cm.^{2}/day, the higher figure pertaining to alloys richer in the second metal of the system. The depth of penetration of Au into Pt, Pd, and Ni increases in the order named. 10 references. Ha (10)

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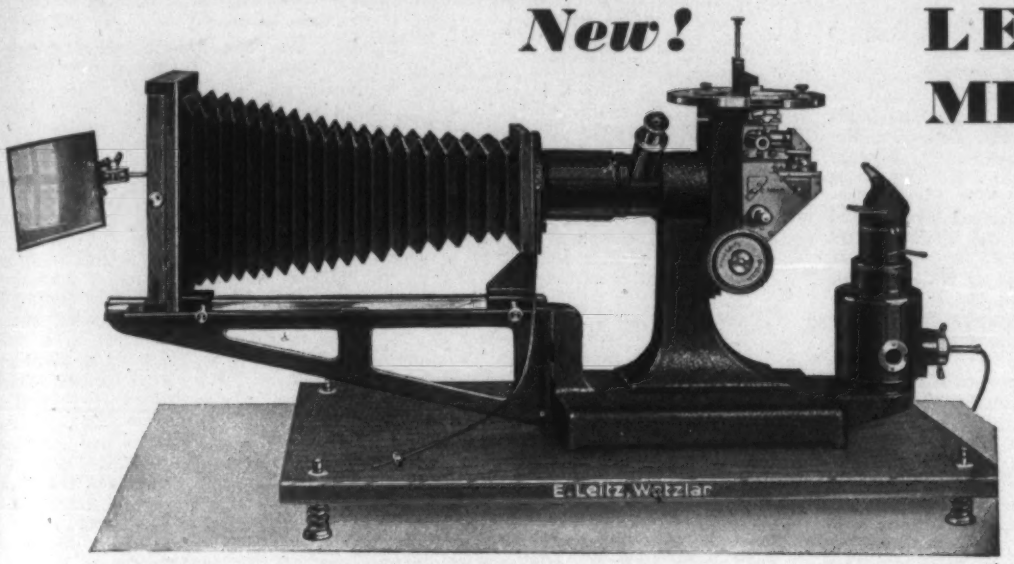

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Laws of Transformation in the Solid State of Metals. (Gesetzmässigkeiten bei Umwandlungen im festen Zustand der Metalle.) U. DEHLINGER. *Metallwirtschaft*, Vol. 12, Apr. 14, 1933, pages 207-210. In the past most metallurgical investigations were only concerned with materials in a state of equilibrium, such as the preparation of constitutional diagrams. To complete our knowledge of these materials their kinetics have been more recently investigated, that is the intermediate stages of transformation and its speed. Kinetics are important as most metals as used practically are not in a state of equilibrium. Reactions which occur during the heat treatment of metals can be grouped into lattice changes and precipitation of a second crystal form with only a small lattice change. Kinetic curves can be obtained by determining properties of the metals which are definitely related to the transformations after quenching and drawing operations at various temperatures and for various lengths of time. The transformation of one lattice into another can be two phase or growth process, in which the intermediate stage consists partly of one kind of lattice and partly of the other kind. Or it can be single phase or constant process, in which the intermediate stage consists of one kind of lattice which has a form intermediate between the initial and final lattice forms. 16 references. GEM (10)

The Wave-Lengths of the Silver, Molybdenum, Copper, Iron and Chromium $K\alpha_1$ Lines. J. A. BEARDEN. *Physical Review*, Vol. 43, Jan. 1933, pages 92-97. A double crystal spectrometer can be used to measure X-ray wave-lengths with a precision as great or greater than that obtained by the usual methods. Purpose of present work to determine X-ray wave-lengths of several important lines by using such a spectrometer and compare results with most precise values obtained by other methods. Results on Ag and Mo agree satisfactorily with photographic methods. Lines for Cu and Cr differ considerably from photographic methods. When a series is found to be asymmetrical the double crystal spectrometer has a decided advantage in the measurement of wave-lengths. WAT (10)

Mosaic Structure of Crystals (Über die Mosaikstruktur der Kristalle) F. BLANK. *Physikalische Zeitschrift*, Vol. 34, May 1, 1933, pages 353-368. Reviews experimental investigations into mosaic structure phenomenon based on microscopic, magnetic, electric and thermal measurements. Next effect of mosaic structure upon absolute wave length determination of X-rays with crystals are dealt with followed by a chapter on X-ray interferences. Balance of paper pertains to theoretical publications on secondary and mosaic structures. Zwicky's theory predicted the existence of regular super (secondary) structures which have been experimentally confirmed in crystals of Bi, Cu, Co, Ni, Fe, Cd, Zn independent of the growing conditions. The optically established secondary planes also exhibited mechanical preferences as proved in Cd and Zn crystals. Etching tests and depositions of insoluble foreign atoms on the secondary planes furthermore corroborated the anticipations of theoretical assumptions. EF (10)

Some Advance Remarks Regarding the Application of the Results of X-ray Study of the Structures of Pressed Duralumin to Technological Practice. E. F. BAKHMETEV. *Proceedings Aviation Materials Research Institute*, Vol. 1, 1933, pages 122-128. (In Russian.) Points at the conditions to be fulfilled for production of fine grained metals after hot and cold working and the value which X-ray methods might have for production work. (10)

X-ray Structure Analysis of Metals Deformed by Impact at High Temperatures. E. F. BAKHMETEV & C. I. GUBKIN. *Proceedings Aviation Materials Research Institute*, Vol. 1, 1933, pages 34-49 (In Russian). Specimens of duralumin were deformed by impact at 450° C. and quenched in water. Interval between deformation and quenching was less than 0.3 second. Specimens were studied by X-ray method. No difference between character of deformation at room temperature and at 450° C. was observed. Presence of $CuAl_2$ lines shows that impact did not raise temperature to 500° C. or time at it was not sufficient for solution. (10)

6

Applied X-rays. (Ergebnisse der technischen Röntgenkunde III. Wechselwirkung zwischen Röntgenstrahlen und Materie in Theorie und Praxis.) Edited by J. EGGERT & E. SCHIEBOLD. Akademische Verlagsgesellschaft, Leipzig, 1933. Cloth, 6½x9¼ inches, 211 pages. Price 18.80 RM. The third volume of this series resembles the first two and is a collection of 5 to 10-page papers principally by German experts. The first part of the book, containing articles by von Laue, Debye, Heisenberg, James, Mark, Coster, and Noddack is of little interest to anyone who is unfamiliar with the modern theories of X-ray scattering, dispersion, and emission. Those concerned with these fields, however, will find the chapter on X-ray and electron scattering by P. Debye, on structure factors by R. W. James, and on dispersion by Mark, especially profitable reading.

7

The second portion of the book is devoted to new apparatus and methods. W. Noddack's concise survey of the present state of chemical analysis by X-ray spectroscopy properly belongs here rather than in the first part where it is placed. In the chapters devoted to new apparatus, descriptions are given of new portable equipment for radiography, of power plants and X-ray tubes for extremely high voltages, of a new vacuum spectrograph, and of X-ray tubes employing the rotating anode principle. An article by Seemann covers the physics of demountable electron and ion tubes. All of these chapters contain numerous excellent illustrations.

The present state of radiography by the use of gamma rays is reviewed by L. Luft. The treatment covers the theory of the method, its practical advantages and disadvantages, and some examples of its use. Advances in X-ray radiography are presented by M. Widemann, with attention to the inspection of heavy metal objects. Exposure curves are given for iron, copper, and lead. A short chapter by R. Berthold covers the radiographic detection of alterations in old paintings.

8

F. Regler discusses two X-ray methods of determining strains in metals: the measurement of the radial widening of diffraction rings, and the measurement of peripheral widening of individual spots on these rings. The chapter is a good summary of his several papers in this field.

W. Schmidt describes a powder diffraction apparatus for use at high temperatures and gives the results of an X-ray determination of the lattice dimensions of alpha, gamma, and delta iron (20° to 1435°). The volume decrease in the transformation from alpha to gamma iron is about 1.0% and the volume expansion in the transition from gamma to delta is about 0.4%, as calculated by these X-ray diffraction data from electrolytic iron. E. Schiebold, in a brief review, gives some thirty references to the more important papers of the last three years on the determination of crystal structure.

9

For those unfamiliar with this series it should be stated that it provides brief but authoritative summaries of the most recent developments in the field of theoretical and applied X-rays, which one may use to supplement the standard reference books in the field. Charles S. Barrett (10)-B-

X-ray Investigation of Influence of Deformation Speed on Structure of Alloy Compressed at High Temperatures. E. F. BAKHMETEV. *Proceedings of Aviation Materials Research Institute*, Vol. 1, 1933, pages 1-33 (In Russian). Duralumin cylinders (16 mm. sq.) were compressed in an Amsler press at different rates and different temperatures. Their structure was fixed by quenching and studied by X-ray method. The speed of recrystallization increases with the temperature at which deformation takes place. Varying the speed of deformation it is possible to have a full or partial recrystallization or strained structure at the same temperature. On recrystallization at 450° C. of cold worked duralumin Laué dots are sharp. At same temperature recrystallization of hot deformed metal gives blurred dots. Deformation causes a conglomeration of small approximately similarly oriented crystallites, temperature rapidly restored normal space lattice, and these conglomerates produce blurred dots. (10)

10

PROPERTIES OF METALS AND ALLOYS (11)

Non-Ferrous (11a)

A. J. PHILLIPS, SECTION EDITOR

The Magnesium-Rich Alloys of Mg-Al-Cu (Etude des alliages magnesium-aluminium-cuivre, riches en magnesium) P. BASTIEN. Doctor's Thesis, Series A, No. 1391. University of Paris, 1933. Paper, 7¼ x 10½ inches, 91 pages. Twenty-one alloys containing 3 to 15% Al, Cu or both, were prepared in 3% steps, using Mg containing 0.4% Al, 0.2% Si, Al containing 0.25% Fe, 0.15% Si and electrolytic Cu containing a trace of Sn. The Mg-Cu alloys thus contained both Al and Si; in the binary and ternary alloys with Al, the chief impurity was Si. The alloys were melted in 25 kg lots in an iron crucible under a $MgCl_2$-NaCl flux, poured at 700° C. into green sand containing 5% S or into ingot molds or chills. A few alloys of higher Mg content, up to 50%, were made in 250 g. lots.

The alloys studied can be considered as being those of the system Mg-Mg_4Al_3-Mg_2Cu. By thermal analysis the ternary diagram was deduced, a photograph of a solid model and several isotherms are shown.

Evidence of the existence of a compound $Mg_2Cu_3Al_2$, melting at 880° C. was found. Ternary eutectics at 412° and 484° C. contain respectively 56.5% Mg, 26.5% Al, 17% Cu and 67.5% Mg, 0.5% Al, 32% Cu.

No study was made of the precipitation hardening possibilities of the alloys with around 9% Al, attention being paid only to the general outlines of the equilibrium diagram.

Micrographs of the structures are given. Brinell hardnesses are plotted for annealed, sand cast, chill cast, forged and drawn material. Thermal expansion, density and electrical conductivity were determined, and thermal conductivity calculated from the electrical. In the series up to 15% Al or Cu, the alloys with over 9% Al were not forgeable, those with over 6% Al or 9% Cu difficultly forgeable while the others, including the alloys of 12% Cu, 3% Mg and 9% Cu, 6% Al could be forged at 425-475 C. All the alloys of this series could be drawn into wire of 25 mm. diameter from a 95 mm. diameter ingot, in one cold pass. Such wires and bars of 14 mm. diameter, 125 mm. breaking section, turned down from 20 mm. diameter sand cast bars were given tensile test. Static bending tests and impact tests were made using the Mesnager notch. Endurance limits, to 100 million cycles, were determined. In general, the best mechanical properties were obtained with alloys containing 3 to 9% Al, the presence of Cu having relatively minor effect. Corrosion resistance in HCl, citric acid, and $MgCl_2$ solutions and in sea water was generally best in this range of Al content. The presence of Cu was harmful.

H. W. Gillett (11a)-B-

Some Effects of the Addition of Tellurium to Lead. W. SINGLETON & BRINLEY JONES. *Engineer*, Vol. 155, Mar. 17, 1933, page 266; *Engineering*, Vol. 135, Mar. 17, 1933, pages 310-311, 317-318. Include discussion. Short abstract of paper read before the Institute of Metals, London, March 8, 1933. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 335. LFM (11a)

Casting Properties of Nickel Bronzes. N. B. PILLING & T. E. KIHLGREN. *Metal Industry*, London, Vol. 41, Dec. 30, 1932, pages 631-633; Vol. 42, Jan. 6, 1933, pages 11-13. Paper presented before the American Foundrymen's Association. See *Metals & Alloys*, Vol. 4, July 1933, page MA 235. Ha (11a)

Effect of Metallic Additions to Cast Aluminum Alloys (Einfluss einiger metallischer Zusätze zu gegossenen Aluminiumlegierungen) *Die Metallbörse*, Vol. 22, Sept. 24, 1932, page 1231. By adding Pb, Na and Cd to Al alloys with 8.2 and 12.4% Cu, the microstructure but not the physical properties of these alloys are changed according to Loskiewicz and Perchorowicz. But by adding 0.1-0.25% Cd to an Al alloy with 4.1 Cu, 10.23 Zn, 0.39 Si, the tensile strength is raised from 13.33 to 16.58 kg./mm.^{2} and elongation from 3.21 to 4.79% with chill casting. In sand casting, the tensile strength rises from 13.85 to 15.26 kg./mm.^{2} and elongation from 5.04 to 6.48%. Cd is added 5-10 min. before pouring at 750° C. EF (11a)

Sodium Content of Silumin (Der Natriumgehalt des Silumins) E. SCHEUER. *Zeitschrift für Metallkunde*, Vol. 25, June 1933, pages 139-141, 157-160. It is shown that the Na in Silumin may be determined by melting a sample in air, extracting the surface of the subsequently frozen sample with water, and titrating the resultant alkali solution. When the Na content is below 0.003%, no modification obtains in the alloy. Normal modified Silumin contains about 0.010% Na. When the Na content is over 0.015% the alloy is "over-modified." RFM (11a)

Calcium Metal. Its Extending Industrial Applications. *Chemical Trade Journal & Chemical Engineer*, Vol. 90, June 3, 1932, pages 546-547. Abstract of an article by C. L. Mantell & C. Hardy in *Metal Progress*, Apr. 1932. From *The Engineer*, Metallurgical Supplement, May 27, 1932. See *Metals & Alloys*, Vol. 3, Dec. 1932, page MA 362. JN (11a)

Phosphorus in Red Brass. R. W. PARSONS. *Foundry*, Vol. 60, Aug. 1932, pages 16-17, 48; *Metal Industry*, London, Vol. 41, Sept. 30, 1932, pages 317-318, 322; Oct. 7, 1932, page 344; *Metal Industry*, New York, Vol. 30, Nov. 1932, pages 433-435. See *Metals & Alloys*, Vol. 4, July 1933, page MA 235. PRK + Ha + VSP (11a)

Effect of Nickel on Some Copper Alloys for Foundry Use (Influence du Nickel sur quelques alliages cuivreux utilisés en fonderie) N. B. PILLING & T. E. KIHLGREN. *Revue du Nickel*, Vol. 4, Jan. 1933, pages 29-35. See "Some Effects of Nickel on Bronze Foundry Mixtures," *Metals & Alloys*, Vol. 3, Jan. 1932, page MA 25. AH (11a)

Capillary Lubrication by Means of Oil-containing Bronze. R. N. R. *Machinery*, London, Vol. 42, June 8, 1933, pages 282-284. Discussion of a strong and ductile alloy, of which as much as 50% of the volume is taken up by air spaces. The air may be removed and replaced by oil, thus providing a self-lubricating bearing. A typical alloy contains 90% Cu and 10% Sn, a composition being commonly employed for good anti-frictional properties. The material is pure virgin metal in the form of fine powder, mixed and briquetted under high pressure in dies. The brittle mixture is submitted to a sintering process. True welding occurs, proved by the fact that on fracturing the alloy the fracture runs through the original grains rather than at the welded points. Kz (11a)

Special Alloys. (Speziallegierungen.) *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, June 25, 1933, page 268; July 9, 1933, page 288; Aug. 6, 1933, page 330; Aug. 20, 1933, pages 349-350. The above installments of this review consider composition, properties and application of the following alloys: Cowles Al bronzes, Corson alloys, Crotorit, Cuivre Poli, Cupror, Cothias die casting alloys, Cowles Mn bronze, Carbon bronze, Cufenium, Cunniloy, Cupranium, Custans bearing metal, Cymric pewter, Diamler bearing bronze, Damaskus bronze, d'Arcet's easy fusible alloys, Dandelion metal, Davis metal and Dawson bronze. GN (11a)

Lead Reactions in Bearing Metals. CHARLES VICKERS. *Foundry*, Vol. 60, Aug. 1932, page 37. Bearing metals usually contain more or less Pb. Some alloys contain from 1 to 4% Zn with proportionate amount of Cu, without harm to alloy. Zn promotes solidity in alloys. Alloy of 80% Cu, 10% Sn, 10% Pb is likely to contain oxides and sulphides. If CuO is present in alloy of Cu with Pb and other metals, the oxide is reduced by the Pb forming metallic Cu and PbO. Cu_2S and PbO should remain in metal as solids. If any sulphides or oxides are present, a gas is developed of which 80% is retained by solid metal. VSP (11a)

Production of Be-Mg Alloys. (Zur Herstellung von Beryllium-Magnesiumlegierungen.) *Die Metallbörse*, Vol. 23, Dec. 10, 1932, page 1583. The great variety of attempts to secure Be-Mg alloys are reviewed showing that these light metals are insoluble in one another. EF (11a)

1 **Duralite, a New Al Cast Alloy. (Duralite, eine neue Aluminiumgusslegierung.)** *Die Metallbörse*, Vol. 23, Jan. 28, 1933, page 115. A new casting alloy intended for light metal pistons has been developed by C. Panseri. The alloy of 3% Cu, 0.7% Si, 0.5% Ni, 0.5% Mg, 1.5% Fe, 0.2% Ti, balance Al combines the favorable physical properties of the "Y" alloys with the foundry properties of Cu-rich Al alloys. EF (11a)

"Tin-Free" Leaded Bearing Bronze. H. K. HERSCHMAN & J. L. BASIL. *Bureau of Standards Journal of Research*, Vol. 10, May 1933, pages 591-608. A study was made of the effect of small proportions of various elements on the distribution of Pb in leaded bronzes containing more than 30% Pb. Mechanical properties believed to be significant in the service of a bearing were determined at several temperatures up to 250° C. for leaded bronzes containing
2 30.5-40% Pb, together with small percentages of S, Si and Zr. Service tests were made on a set of connecting rod and main bearings of the S-Si-Zr leaded bronze in a Wright type J-5 airplane engine. These bearings were prepared in a commercial plant from an alloy containing 35% Pb, 0.4% S, 1.5% Si-Zr alloy and remainder Cu. Individual additions of Ba, Ca, Zr or S to leaded bronzes showed promise in aiding in the prevention of segregation of the Pb under the casting conditions used. A leaded bronze free of both Sn and Sb and containing S and Si-Zr alloy was developed. Pb content (45%) was highly dispersed and uniformly distributed. Microstructural examination and mechanical tests indicated that the optimum additions to a high-Pb bronze containing S and Si-Zr alloy should be 0.4% S and 1.5% Si-Zr alloy. Wear resistance of S-Si-Zr-treated was superior
3 to regular commercial alloys, some of which contained 6% Sn. Compression strength was as high in new alloy as commercial alloys containing 10% less Pb. Resistance to pounding of new alloy was not materially affected by temperatures between 100 and 250° C. Alloy may be handled commercially for manufacture of bearings. WAT (11a)

Antifriction Alloys Tin-Lead-Copper-Antimony (Les Alliages Antifrictions Etain-Plomb-Cuivre-Antimoine) FOURNIER. *Cuivre et Laiton*, Vol. 5, Dec. 15, 1932, page 568. Systematic study of antifriction metals of a Sn-base was made by using 36 definite compositions, of which 2 ingots were made of each: one slowly cooled, the other cast in a metal mold. Results derived from chemical and micrographic examination can be summarized as follows: 1. binary alloys Sn-Pb indicate 2 solid solutions with eutectic at 64% Pb; 2. binary alloys Sn-Cu show
4 a eutectic between solid solution (Cu, Sn) and Sn formation of which increases with Cu content; 3. binary alloys Sn-Sb: up to 8%, Sb is soluble in Sn between 8 and 50%, Sb is in equilibrium with solid solution Sb-Sn. These alloys have a tendency to segregation at slow cooling while metal is homogeneous at rapid cooling; 4. ternary alloys Sn-Pb-Sb with up to 8% Sb are heterogenous and liberate solid solution on slow cooling; 5. ternary alloys Sn-Pb-Cu seem to have superposed characteristic of Sn-Cu and Sn-Pb alloys; addition of Pb seems to favor growth of solid solution crystals Cu-Sn. 6. Alloys Sn-Cu-Sb have a tendency to grow Cu-Sn crystals; Cu opposes segregation of alloys with more than 8% Sb. 7. Alloys Sn-Sb-Pb-Cu show that favorable influence of Cu makes itself felt with regard to partial segregation even after slow cooling. Micrographic examination
5 permits estimating Sb-contents above 8% (cubic crystals) and Cu content (white needles of characteristic appearance). Brinell tests show an increase of hardness with increase of Sb, and an additional increase by addition of Cu. Ha (11a)

Binary Alloys of Magnesium (Les alliages binaires de magnésium) A. DUMAS & F. ROCKAERT. *Revue de l'Aluminium et de ses applications*, Vol. 9, May-June 1932, pages 1717-1728. The most important commercial binary alloys of Mg with Al, Zn, Sn, Cu, Ce, Cd, Mn, Ca, are reviewed from the standpoint of their respective equilibrium diagrams and their physical and mechanical properties. Owing to the low solubility of Fe in Mg iron crucible may be used for the melting of Mg and its alloys. The diagrams are characterized by definite compounds having a very low solubility. Al and Zn, however, will dissolve into Mg to the
6 extent of 11% and 8.2% respectively at the eutectic temperature. All alloys have a density of about 1.8. Mg crystallizes in the hexagonal system and the mechanical properties of the alloys are characteristic of this crystal structure. AH (11a)

Electro-chemical Investigation of Brass (Eine elektrochemische Untersuchung von Messing) ARNE ÖLANDER. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 164, June 1933, pages 428-438. The same equipment previously used for the determination of electrode potentials of Ag-Cd alloys (See *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 163, Jan. 1933, pages 107-121) was employed for the Cu-Zn system. The potential of the cell Zn_{liquid} | (Li, Rb, Zn) Cl | $(Zn, Cu)_{solid}$ and its temperature coefficient was measured for 46 alloy electrodes over the temperature range from 333°-626°C. The constitutional diagram previously
7 published by Bauer & Hansen (*Mitteilungen des Materialprüfungsamts, Berlin-Dahlem*, No. 4, 1927) was completely affirmed except the inclination of the γ-phase which showed the same tendency as found by Jitsuka (*Memoirs College of Science, Kyoto*, [A], Vol. 8, 1925, page 179). The activity coefficient of Zn in the η-phase was equal to the unit within the limits of experimental errors. The γ-phase has a defined structure Cu_5Zn_8 whereas the atoms are arranged at random in the ϵ-phase. The β-phase seems to have a defined structure above as well as below the β-brass transformation. The transformation of $\beta + \gamma$ took place at 460° C. while the δ-phase decomposed at 562° C. The experimenter estimated that an alloy of the exact composition CuZn exhibits a degree of disorder of 1.0%. The transformation heats of the $\beta \rightarrow \beta'$ and $\delta \rightarrow \gamma + \epsilon$
8 transitions are calculated amounting to 87 cal./atom and 195 cal./atom respectively. The melting heat of Zn was found to be 28.4 cal./g. EF (11a)

Present Metals and Alloys in General and Copper Alloys in Particular (Metaux et Alliages Actuels en General et Alliage de Cuivre en Particulier) J. OTTELET. *Cuivre et Laiton*, Vol. 5, Nov. 30, 1932, pages 535-536. Present trends in improving mechanical properties are in direction of increasing ultimate strength and elastic limit in order to increase fatigue strength; the improvement of the modulus of elasticity which, however, has not been successful, 22000 kg./mm.^{2} being the maximum; the addition of Be promises good results, 30000 kg./mm.^{2} having so far been obtained. Light weight, corrosion resistance and heat resistance are further objects of investigations. Several special steels and cast-irons and Cu, Ni and Al alloys are discussed; a good material for condenser tubes was found in
9 78% Cu, 20% Zn and 2% Al. Heat treatment for these materials is briefly discussed. A Cu-alloy with 3% Be under proper heat treatment gives an ultimate strength of 130 kg./mm.^{2} Ha (11a)

Aluminum-Manganese-Magnesium Alloy. D. B. HOBBS. *Metal Industry*, London, Vol. 41, Aug. 5, 1932, page 126. An alloy, known as 4S, containing about 1% each of Mn and Mg, is used in superstructures of 70 ton hopper cars and also for structural purposes due to its good mechanical properties.

	Temper	Tensile strength tons/in.^{2}	Yield point tons/in.^{2}	Elongation %	Brinell Hardness	Shear strength tons/in.^{2}	Min. bend dia. in times thickness
10	Annealed	11.6	4.5	20	45	7.1	0
	½ hard	15.6	13.8	5	65	8.5	2
	Hard	18.7	17.0	3	80	9.8	difficult to bend

Compression strength and compressive yield point are similar to tensile strength and yield point. The endurance limit is 14,000-16,000 lbs./in.^{2} according to temper. Ha (11a)

Electrical Resistance of Palladium Wires Loaded with Hydrogen Between 160 and 310°C. (Der elektrische Widerstand wasserstoffbeladener Palladiumdrähte zwischen 160 und 310°C.) H. Brüning & A. Sieverts. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 163, Mar. 1933, pages 409-441. The electrical resistance of Pd wires has been determined in an atmosphere of H at 160°-310° C. Furthermore the amount of absorbed H has been measured between 160° and 200° C. and conclusions are derived from these measurements in regard to the structure of the Pd-H alloys. The isotherms proved to be reversible only if one solid phase occurs. In the neighborhood of 300° C., the differences between both solid phases established vanish. There is no reason to bestow the formula Pd_2H upon the beta phase, whose upper concentration border line is still unknown. EF (11a)

Effect of Temperature and Pressure on Adsorption of Hydrogen by Nickel (Über den Einfluss von Temperatur und Druck auf die Adsorption von Wasserstoff durch Nickel) Th. Bahr. *Brennstoff Chemie*, Vol. 14, May 1, 1933, page 174. Preliminary tests of Smittenberg revealed that the adsorption power of Ni with respect to H_2 depends on the method of preparing the metal. Ni-oxide annealed prior to reduction with H_2 adsorbed only ½ quantity gas of a preparation which had not been heated above 300° C. The adsorption tests were accomplished in an electric furnace. After attaining equilibrium conditions, the unadsorbed H_2 was pumped off and the volume adsorbed determined. The pressure range was 1-767 mm. and the 210°, 123° and 15° C. isotherms were determined besides the 760 mm. isobar. All isotherms were reproducible for rising and falling temperatures. Below 10 mm. the degasification of Ni took place at an extremely slow rate and was not completed after 5 days. EF (11a)

Special Brasses. (Spezialmessinge.) *Die Metallbörse*, Vol. 23, Jan. 14, 1933, pages 49-50; Jan. 21, 1933, pages 81-82; Jan. 28, 1933, pages 113-114. Following a previous list of special Al alloys on the market (See *Metals & Alloys*, Vol. 4, May 1933, page MA 133R1) an alphabetical collection of trade names covering CuZn alloys with various additions is presented. The chemical analyses of some 340 alloys on CuZn base are compiled. 54 references. EF (11a)

Copper-Tin Alloys. II. Bell Metal, Gun Metal and Speculum Metal. *Tin*, Apr. 1933, pages 15-18. Bell metal is a "true bronze" in which only Cu and Sn are present; compositions vary from 40-85% Cu, while Sn varies from 16% to 87.5% in case of small hand bells. Gunmetals can be true bronzes but more often it is the ternary alloy Cu-Sn-Zn. Admiralty metal contains these in the ratio 88:10:2. This metal is cast at 1200° C. Pb is sometimes added in small quantities when used as bearing metals to improve wearing qualities. Speculum metal is essentially a white bronze with about 30-33% Sn and 70-67% Cu. It is mostly used for mirrors as it tarnishes less than Ag. Properties and treatment are briefly discussed. Ha (11a)

Low Melting Alloys. (Laagsmeltende legeeringen.) *Polytechnik Weekblad*, Vol. 27, Mar. 16, 1933, pages 164-165. The analyses of some 75 alloys mostly comprising Bi, Cd, Pb and Sn which melt between 65.5° and 181° C. are given. The lowest m.p. of 65.5° C. has analysis: 49.5% Bi, 10.10% Cd, 27.27% Pb, 13.13% Sn while an alloy with 37% Pb and 63% Sn melts at 181° C. WH (11a)

A Revision of the Atomic Weight of Potassium. Gregory Paul Baxter & William Marshall MacNevin. *Journal American Chemical Society*, Vol. 55, Aug. 1933, pages 3185-3190. The value found is 39.094, confirming the results of Richards and Staehler and Richards and Mueller (39.096). MEH (11a)

Investigation of Critical Deformation Range in German Silver and Aluminum Bronze. W. S. Bugakov. *Journal tekhnicheskoj fiziki*, Vol. 2, May 1932, pages 173-189 (in Russian). Mechanical properties, solubility in HNO_3, electrical resistance and density have been investigated for samples of German silver (20% Ni) and of Al bronze (6% Al), subjected to various degrees of deformation. Similarly to the previously studied behavior of brass, there is a marked change in all properties studied in the region corresponding to 20%-30% reduction of area. Microstructure shows the beginning of a marked elongation of grains after 25%-30% deformation. Study of Lüders lines in Al bronze reveals the appearance of doublet lines at the beginning of critical deformation range. A short theoretical study of results obtained follows, in which the role of grain rotation during the critical range is stressed. LI (11a)

The Solubility of Silver in Mercury. II. Robert E. DeRight. *Journal of Physical Chemistry*, Vol. 37, Apr. 1933, pages 405-415. Amalgams as dilute as 0.06 atomic % have been prepared and analyzed with a precision approaching one part/thousand. 128 determinations of the solubility of Ag in Hg in the range 20°-80° C. have been made. Several forms of Ag and intermetallic compounds have been used as the solid phase. Between 20° and 80° C., the solubility changes according to the equation $\log N = \frac{-1105.8}{T} + 0.5894$. The relation of the term "solubility" to particle size has been briefly discussed. EF (11a)

Alloys of Praseodymium and Aluminum. (Le leghe fra praseodimio e alluminio.) G. Canneri. *Alluminio*, Vol. 2, Mar.-Apr. 1933, pages 87-89; *La Metallurgia Italiana*, Vol. 25, Apr. 1933, pages 250-252. Thermal and micrographic studies have been made on the system Pr-Al, and the equilibrium diagram determined. 3 compounds have been identified; PrAl (identified by the existence of a transition point at 906° C.) $PrAl_2$ melting at 1442°, and $PrAl_4$ melting at 1244°. $PrAl_4$ exists in 2 allotropic modifications, the temperature of transformation being 1018°. The a-form is stable at ordinary temps. and is denser, its formation from the b-form being accompanied by a noticeable decrease in volume. The properties, including the pyrophoretic characteristics, are similar to the corresponding La alloys. AWC (11a)

The Properties of Commercial Varieties of Copper at High Temperatures. T. G. Bamford. *Engineering*, Vol. 134, Oct. 28, 1932, pages 523-524. Condensed from paper read before the Institute of Metals, Sept. 1932. See *Metals & Alloys*, Vol. 4, July 1933, page MA 237. LFM (11a)

Properties of Monel Metal and Similar Copper-Nickel Alloys. (Die Eigenschaften von Monel-Metall und ähnlichen Kupfer-Nickellegierungen.) O. Bauer & J. Weerts, in collaboration with O. Vollenbruck. *Zeitschrift für Metallkunde*, Vol. 25, May 1933, pages 121-123. Original article in *Metallwirtschaft*, Vol. 11, 1932, see *Metal & Alloys*, Vol. 4, Sept. 1933, MA 277. RFM (11a)

Strong Light Alloys of To-day. Leslie Aitchison. *Metallurgia*, Vol. 8, May 1933, pages 15-17. General discussion of Al- and Mg-base wrought alloys. Properties of several commercial alloys are listed. JLG (11a)

Elektron-light-metal. (Elektron-Leichtmetall.) *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 23, Dec. 28, 1932, page 738. Various applications of elektron-light metal of I. G. Farbenindustrie, Bitterfeld, during the "Deutschlandflug" are discussed. Density of 1.80-1.83 is from 33-40% lower than that of Al alloys. Properties given are: upper m.p. = 625°-650° C., lower m.p. = 400° C., shrinkage about 1.3%, heat expansion for cast alloys = 0.0000255, for piston alloys = 0.0000240 (between 20° and 100° C.); tensile strength up to 42 kg./mm.2. Kz (11a)

Corrosion-resistant "AW 15" Aluminum Alloys. (Korrosionsbeständige "AW 15" Aluminiumlegierungen.) *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 23, Aug. 12, 1932, page 474. An alloy of the Aluminium-Walzwerke Singen, that contains less than 2% Mn, besides Fe and Si. The alloy has greater strength than Al, is sea-water resistant, and can be readily soldered and welded. Kz (11a)

Lead Bronzes. (Bleibronzen.) *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 24, Jan. 14, 1933, page 34. Sn bronzes with high Pb contents are utilized for highly stressed bearings. After heating to 1100°-1200° C. the casting temperature should not be lower than 1000° C. to obtain a homogeneous solution of the components. It is advisable to use green sand for molds. With increasing Pb contents the Sn content must be cut down, while 2.5% Ni exerts a favorable influence. Kz (11a)

Special Alloys. (Spezial-Legierungen.) *Zeitschrift für die gesamte Giesserei-praxis*, Vol. 54, June 4, 1933, pages 227-228. This installment describes composition, properties and use of the following non-ferrous alloys: Coleco bearing metal, Coles metal, composition metal, constructal No. 2, Colorado metal, constructal No. 8, Cornish bronze, Coopers alloys, corronil, corronium and chronit. GN (11a)

Age-Hardening of Pure Al Alloys. (Alters-Härtung reiner Al-Legierungen.) *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 23, Nov. 14, 1932, page 531. In case of high chemical purity of the constituents of Al alloys, it is found that alloys with 4% Cu age-harden considerably at room temperatures, while the presence of 0.25% Si is of no influence. Fe prevents or aggravates age-hardening, whereas Mg favorably influences the process. In case of duralumin of ordinary purity Mg_2Si plays an important role in age-hardening, whereas the process will not be influenced by Mg in case of pure Al that partly forms Cu Al_2, impurities of 0.35% Fe being unimportant. Kz (11a)

High Aluminum Binary Aluminum-Manganese Alloys. (Ricerche intorno alle leghe binrie Al-Mn ricche di alluminio.) *Alluminio*, Vol. 1, Nov.-Dec. 1932, pages 361-367. Mechanical, chemical and structural properties of Al-Mn alloys have been studied, especially up to 3.5% Mn. By means of conductivity tests, certain points on the equilibrium diagram, particularly the solubility of Mn in Al in the solid state have been revised. Alloys containing 1.2-1.5% Mn show highest resistance to corrosion by NaCl plus H_2O_2. Addition of Mn does not injure the wire-drawing properties, and up to 1.4% Mn tensile strength is improved; beyond this amount, effect is slight. Alloys annealed below 250°-300° C., the limit of recrystallization, show considerable variation in properties. Electrical conductivity diminishes with increased Mn up to 1.4%, beyond which, the conductivity curve flattens out. Alloy containing 1.2-1.5% Mn is known as Alumen. AWC (11a)

Tellurium Lead. *Industrial Chemist*, Vol. 9, May, 1933, pages 159-160. Résumé of properties. RAW (11a)

Developments in Aluminum Alloy Die-casting. *Machinery*, London, Vol. 42, Apr. 20, 1933, pages 61-66. General discussion and examples of pressure and gravity fed die-castings and sand castings. Details and application of various alloys are given, the mechanical properties of which are presented in a table. 2L5 alloy contains 2.5-3% Cu, 12.5-14.5% Zn, remainder being Al. 2L8 alloy contains 11-13% Cu besides Al. L24 or Y-alloy contains 3.5-4.5% Cu, 1.8-2.3% Ni, 1.2-1.7% Mg, with the remainder Al. This alloy offers good resistance to atmospheric and sea-water corrosion and can be improved by heat treatment. Al-Si alloy (Alpex) is composed of 10-13% Si with Al and is suitable for castings that are required to withstand relatively high pressures. Birmasil special alloy resembles Alpex alloy, but has an additional content of up to 3.5% Ni. Birmalite and 122 alloys are piston materials of similar composition, the former having a 10% Cu content with small quantities of Mg and Fe. Birmabright is a highly corrosion and fatigue resistant alloy containing 2-6% Mg and a small quantity of Mn. Pressure die-cast Al alloys and Elektron metal are dealt with. The practice of pressure and gravity die casting and sand is discussed. Kz (11a)

"Birmasil." *Metal Industry*, London, Vol. 41, Nov. 25, 1932, page 518. Birmasil is an Al-Ni-Si alloy with up to 3½% Ni and 8-13% Si; it is a casting alloy for large or small castings of any section, in sand molds and gravity dies. Maximum tensile strength is developed without any form of heat treatment; the alloy possesses a high fatigue resistance, Izod-impact value is 4-5 ft.-lbs.

Mechanical property	Chill cast	Sand cast
Max. stress, tons/in.2	16.19	12-13
Yield point, tons/in.2	7.5-9.5	6-7.5
Elongation, % in 2 in.	3-6	2-4
Brinell	70-80	52-60

The properties at high temperatures are shown in the following table:

Temperature °C	Max. Stress tons/in.2	Elongation % in 2 in.
100	14.5	5.0-6.5
200	10.0-11.3	8.5-10.0
250	8.0-8.25	11.5-13.0
300	5.9-6.2	17.5-18.5

The coefficient of thermal expansion is only 0.000018. Ha (11a)

New British Chemical Standard. *Metal Industry*, London, Vol. 41, Nov. 11, 1932, page 473. This sample is to be used as standard for the analysis of cupro-nickel sheets and strips of the British Standard Specification and has the following composition:

Cu	68.85%	Mg	0.027%
Ni	30.1	C	0.02
Si	0.12	S	0.01
Mn	0.89	Pb not over	0.01
Fe	0.05	Co not over	0.01

Ha (11a)

New Alloy for Pistons. *Marine Engineering & Shipping Age*, Vol. 38, Mar. 1933, page 102. An improved Al piston alloy has been developed in England for internal combustion engines. The Al is alloyed with 10-17% Si, 4-8% Ni, 1-5% Cu, and sometimes 1-2% Mg. Kz (11a)

Gold-Silver-Nickel Alloys. (Die Edelmetalllegierungen von Gold, Silber und Nickel.) *Die Metallbörse*, Vol. 22, Nov. 12, 1932, page 1455. Color of white gold is not only affected by alloy additions of Pt, Pd, Ni and Ni + Zn, but also by thermal treatments. Commercial alloys melting at about 950° C. contain 15-20% Ni and up to 10% Zn. Zn lowers the m.p. and improves the working properties. Either gas-fired or high-frequency furnaces and a cover of boric acid (+ graphite) are employed. For coinage purposes the following alloy has been tried in England: 50% Ag, 40% Cu, 5% Ni and 5% Zn. Deoxidation is performed with P and eventual S-removal by Mg-Cu. The alloy is cast at low temperatures. EF (11a)

The Corson Alloys. (Die Corson Legierungen.) *Die Metallbörse*, Vol. 22, Sept. 24, 1932, pages 1230-1231. To these 91-99.4% Cu alloys, additions of Si, Cr, Fe, Co or Ni are made in such quantities as to form silicides as Ni_2Si, Cr_2Si, Co_2Si and probably Fe_2Si. All 4 series of alloys are subject to age-hardening. An alloy with 4 Ni and 1.9 Si shows 52.5 kg./mm.2 tensile strength, 5% elongation and 175-190 Brinell in the as-cast state. At 7% Ni, the Cu-Si-Ni alloy must be hot-forged, at 5% hot forging must precede hot rolling and at 3% rolling can be started directly. After several passes annealing at 750°-950° C. is required depending on the Ni content. Water quenched alloys are usually ductile showing 50-70% elongation. Cold worked articles made in this state are annealed at 350°-550° C. for 15-30 hrs. which reduces the elongation to 10-18% and raises the Brinell hardness to 180. EF (11a)

Technological Properties of Nickel Bronze. (Die technologischen Eigenschaften der Nickelbronze.) *Die Metallbörse*, Vol. 22, Sept. 3, 1932, pages 1134-1135. Although being widely used in the U. S. A. and in Great Britain, Ni bearing bronzes are only adopted slowly in Germany. The effect of Ni upon bronze is summarized. The analyses of some 16 European and American commercial alloys are collected in a table and data on the influence of 1-3% Ni on yield point, tensile strength, elongation and reduction of area of 90/10 and 84/11 bronze are compiled in a second table. The alloys in which Sn has been replaced by Ni and Zn are dealt with. EF (11a)

Ferrous (11b)

E. S. DAVENPORT, SECTION EDITOR

Gmelin's Handbook of Inorganic Chemistry. Iron. (Gmelin's Handbuch der anorganischen Chemie. Eisen.) 8th Edition. R. Durrer, Editor. Teil A, Lieferung 5. Sponsored by the Deutsche Chemische Gesellschaft. Verlag Chemie, Berlin, 1933. Paper, 7 x 10 inches, pages 847-1166. Price 50 RM. This contains the sections on general physico-chemical foundations for methods for preparation of "forgeable iron," on iron and steel foundries, on ferro alloys and an addendum to the previous volume on iron on production of technical iron, bringing the references well up into 1933. The references throughout the volume are not numbered, but there are thousands of them. 1

The treatment is primarily bibliographical, rather than critical, though data from several observers are often plotted on the same diagram. Diagrams are shown and in many cases equilibrium constants tabulated for the systems Fe-O, Fe-O-C, Fe-Si-O, Si-Fe, Si-O, Si-Fe-C, SiO_2-FeO, Fe-Si-O, Fe-Mn, FeO-MnO, Fe-Mn-O, Fe-P-O, Fe-S-Mn, FeS-MnO, FeS-Al_2O_3, FeS-FeO, FeS-Fe_2O_3, FeS-CaO (MgO), FeS-Na_2O, Fe-S-H, Mn-Si-O, Fe-Ni-O, Fe-Ni-Si-O. Deoxidation by various deoxidizers is discussed.

The foundry section deals with all furnaces and melting processes for ferrous alloys.

The following ferro alloys are dealt with, Fe Si, Fe Mn, Fe Si Mn, Mn Si Al, Fe Al, Fe Si Al, Si Al, Fe Be, Fe B, Mn B, Fe C, Fe Cr, Fe Co, Fe Mo, Fe Cr Mo, Fe Ni Mo, Fe Ni, Fe Si Ni, Fe Cr Ni, Fe Mn Ni, Fe Si Mn Ni, Fe P, P Mn, Fe Ta, Fe Ti, Si Ti, Mn Ti, Fe U, Fe V, Fe W, Fe Si W, Fe Zr, calcium silicide, etc.

It will be useful as a finding list and for very compressed information, but does not contain a very complete discussion of it. H. W. Gillett (11b)-**B-**

The Book of Stainless Steels. E. E. Thum. Editor. American Society for Steel Treating, Cleveland, 1933. Cloth, 6 x 9¼ inches, 631 pages. Price $5.00. The chromium steels used for corrosion resistance and for resistance to high temperatures, ranging from the 5% Cr steels up through 18-8 and the still more highly alloyed heat-resistant alloys are described by some 80 authors in 75 chapters and sub-chapters, from the point of view of metallurgical constitution, fabrication and utilization. Each author is, from his own experience, able to treat his particular section in an authoritative fashion. The firms with which the authors are connected represent practically all the producers of wrought alloys, and a fair proportion of those of cast alloys. While the authors have doubtless not laid every card in their respective hands upon the table, a great deal of information not heretofore as readily available, has been frankly set forth.

Sufficient editing has been done so that, in spite of the multiplicity of authors, little useless repetition is found, and the different chapters are tied together by cross references and footnotes, so that the book reads better than might have been expected.

The only book with which it can be compared is that of Monypenny, and since progress is so rapid in this field, this, being more up-to-date, is, on the whole, better as well as more comprehensive, and it presents American experience and practice.

Such collections of facts in a specific field need to be made at fairly frequent intervals in fields of great importance. The Symposia of the A.S.T.M. and A.F.A., the Alloys of Iron Monographs, books like the Aluminum Industry, etc., serve a most useful purpose. This volume is a worthy addition to the list. 2

It deals with constitution, melting, casting, fabrication, welding, plating, bimetal, properties, effect of minor elements, behavior in corrosion-resistant, tarnish-resistant and heat-resistant uses; evaluation of corrosion-resistance, oxidation-resistance, creep, fatigue and with utilization. The only unsatisfactory part is the "classification and index" which divides the tradenamed alloys and the various compositions made by different producers into classes with letter and figure symbols that require much exercise of memory or leafing over of pages to present the information. It reminds one of the irritating original index to the International Critical Tables. The same data could have been presented far more effectively in tabular form.

The index is extensive, but still fails to include reference to many useful comments tucked away in various sections, so the reader is advised to make his own additions to the index as he reads the book. 3

The paper and binding are good, which is necessary in a book that will be used as much as this complete and authoritative volume will be. H. W. Gillett (11b)-**B-**

Effect of Molybdenum on Cast Iron (Einfluss von Molybdän auf Gusseisen) *Die Metallbörse*, Vol. 22, Nov. 5, 1932, page 1432. Additions of Mo as low as 0.25% greatly improve the properties of cast iron according to Cournot & Challonsonnet, particularly the resistance to wear. EF (11b) 4

Molybdenum in Gray Cast Iron. J. Kentsmith & E. R. Young. *Foundry*, Vol. 60, June 1932, pages 20-21, 58, 60; *La Fonderie Belge*, Vol. 2, Aug. 1932, pages 135-138. Abstract of paper read at Detroit Convention of the American Foundrymen's Association. Mo in gray Fe increases transverse, tensile and fatigue strengths, impact resistance, and to some extent hardness. Important physical effect of Mo on gray Fe is the tendency to increase deflection figures of transverse test. On the average high grade Mo cast irons have shock-strengths at least double those of plain C gray Fe. Includes tables giving nature and dispersal of graphite in a Mo gray cast Fe and progressive effect of Mo or Mo-Cr on cylinder Fe. VSP + FR (11b) 5

Phosphorus in Cast Iron. W. West. *Foundry Trade Journal*, Vol. 48, Feb. 2, 1933, page 90; Feb. 9, 1933, pages 103-105, 114. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 335. OWE (11b) 6

Effect of Nickel Upon Stability of Iron Carbide and Upon Microscopic Structure of White Cast Iron Compositions. Milo J. Stutzman. *Metals & Alloys*, Vol. 4, Apr. 1933, pages 55-58. Previous reports of effect of Ni on white cast Fe are discussed. Experiments by author show that rate of graphitization in first stage bears a direct relation to Ni content. Methods and material used are described. Time for completion of first stage is shown for from 12 hrs. for 0.00% Ni to ½ hr. for 5-10% Ni. Times obtained agreed with calculated times. Micrographs show structure of specimens before and after annealing. Effect of Ni on Ar_1 and the Ac_1 points for Fe-C-Ni alloys of 0.95% Si is shown graphically. Free Fe carbide is unaffected by Ni, but from 0.0 to 3.0% Ni refines grains of ferrite and increases number of C nuclei in malleableized cast iron. At 3.5% Ni a definite change in microstructure of malleableized product takes place; number of C nuclei are greatly increased with uneven distribution. This change is simultaneous with change to martensitic matrix in white iron. WLC (11b) 7

Requirements and Composition of Cutting Tools. J. V. Emmons. *Iron Age*, Vol. 130, Oct. 20, 1932, pages 608-609, adv. sec. page 18; *Machinery*, N. Y., Vol. 39, Dec. 1932, pages 276-278. Abstract of paper read before Machine Shop division of American Society Mechanical Engineers at Buffalo. Commonest form of tool steel is the C. Some C tool steels contain Cr and V. These alloys when present in amounts less than ½% impart valuable properties. Amounts of 1% or higher of Cr, W, Mo and Mn are often added. Most widely used are the high speed steels, such as the 18% W, 4% Cr and 1% V steel. Efforts were made to produce super-high-speed steel by increasing the % of essential alloys, but results have not justified the costs. Use of Co has met with success. Rapid improvements have also been made in use of abrasive wheels. The recent development of hard carbides of W and Ta are of interest. They are made both by fusion and by sintering. Carbide tools will withstand higher temperatures than other metallic tool materials. VSP + RHP (11b) 8

Effect of Addition of Small Amounts of Aluminum on the Castability of Cast Iron (Influence de l'Addition de Petites Quantité d'Aluminium sur la Coulabilité de la Fonte) G. Sirovich. *La Fonderie Belge*, Vol. 2, July 1932, pages 124-125. See "The Effect of Small Additions of Aluminum to Gray Cast Iron," *Metals & Alloys*, Vol. 3, June 1932, page MA 188. FR (11b) 9

Effect of Nickel on Graphitization of Cast Iron. L. Thiery. *Iron Age*, Vol. 129, May 12, 1932, page 1063. Abstract translation of article in *Revue de Metallurgie*. See *Metals & Alloys*, Vol. 2, Aug. 1931, page 153. VSP (11b) 10

Nickel and Nickel-Chromium Malleable Iron (Nickel und nickelchromhaltiger Temperguss) *Die Metallbörse*, Vol. 22, Nov. 19, 1932, page 1487. After annealing alloys with 0.34% Cr + 1.37% Ni and with Ni contents between 0.57 and 2.46% at 910° and 830° C., physical properties were studied by Thiéry. Ni can replace Si in regard to graphitization. 2% Ni induces favorable physical properties, lowers the graphitization temperature and yields a finer and better distributed graphite. Cr counteracts graphitization, varies the hardness of Ni bearing malleable Fe and lowers elongation and impact hardness. EF (11b) 1

Austenitic Cast Iron (Les Fontes Austenitiques) *La Fonderie Belge*, Vol. 2, June 1932, page 109. Abstract of "Cast Irons with higher Ni Additions." See *Metals & Alloys*, Vol. 4, July 1933, page MA 235. FR (11b) 2

Influence of Molybdenum on Cast Iron (Influence du Molybdène sur la Fonte) Jean Cournot & Jean Challonsonnet. *Bulletin de l'Association Technique de Fonderie*, Vol. 16, Sept. 1932 (supplement), pages 49-66. Paper presented at World Foundry Congress, Paris, Sept. 1932. Summary of effects of Mo in steel; ordinary, pearlitic and ferritic cast iron; and malleable cast iron. Physical properties of gray cast iron are improved by addition of molybdenum. Above 2% Mo makes iron difficult to machine. Heat treatments may be used in these cases. Mo and Ni, used together, give high strength to malleable iron. 11 references. WHS (11b) 3

Titanium in Cast Iron. George F. Comstock. *Metal Progress*, Vol. 24, Aug. 1933, page 44. The effects of Ti in cast iron as "closing the grain" are discussed. WLC (11b) 4

Better Castings for Machine Construction. Herbert Chase. *Machinery*, Vol. 39, Sept. 1932, pages 1-5. Deals with advantages of Ni in castings. Advantages secured are: increased hardness; freedom from chilled spots; eliminates the extremely hard carbides; permits the lowering of total carbon; improved surface finish; dense structure; and greater wear resistance. Tensile and transverse strength of the metal can be increased 30% or more by the addition of less than 2% Ni. Gives examples of special application. Table gives compositions suitable for several types of machining tools. Advantages generally offset the greater first cost. RHP (11b) 5

Selenium in 18-8 Steel Improves Free-Machining Properties. *Steel*, Vol. 91, Sept. 26, 1932, pages 23-25. Addition of 0.25% Se to 18-8 Cr-Ni steel greatly improves its free-cutting characteristics and yields a stainless steel tougher than the corresponding high S content Cr-Ni steel and superior for cold working. This opens a field for the commercial manufacture of stainless steel screws and bolts. JN (11b) 6

Alloying Constituent Molybdenum in Malleable Cast Iron and Its Special Importance for Black and White Heart Malleable (Über das Legierungselement Molybdän im Temperguss und seine spezielle Bedeutung für Schwarzguss und weissen Temperguss) J. F. Kesper. *Maschinenkonstrukteur-Betriebstechnik*, Vol. 66, July 10, 1933, pages 95-98. On the basis of certain examples the importance of Mo in malleable cast Fe is discussed. GN (11b) 7

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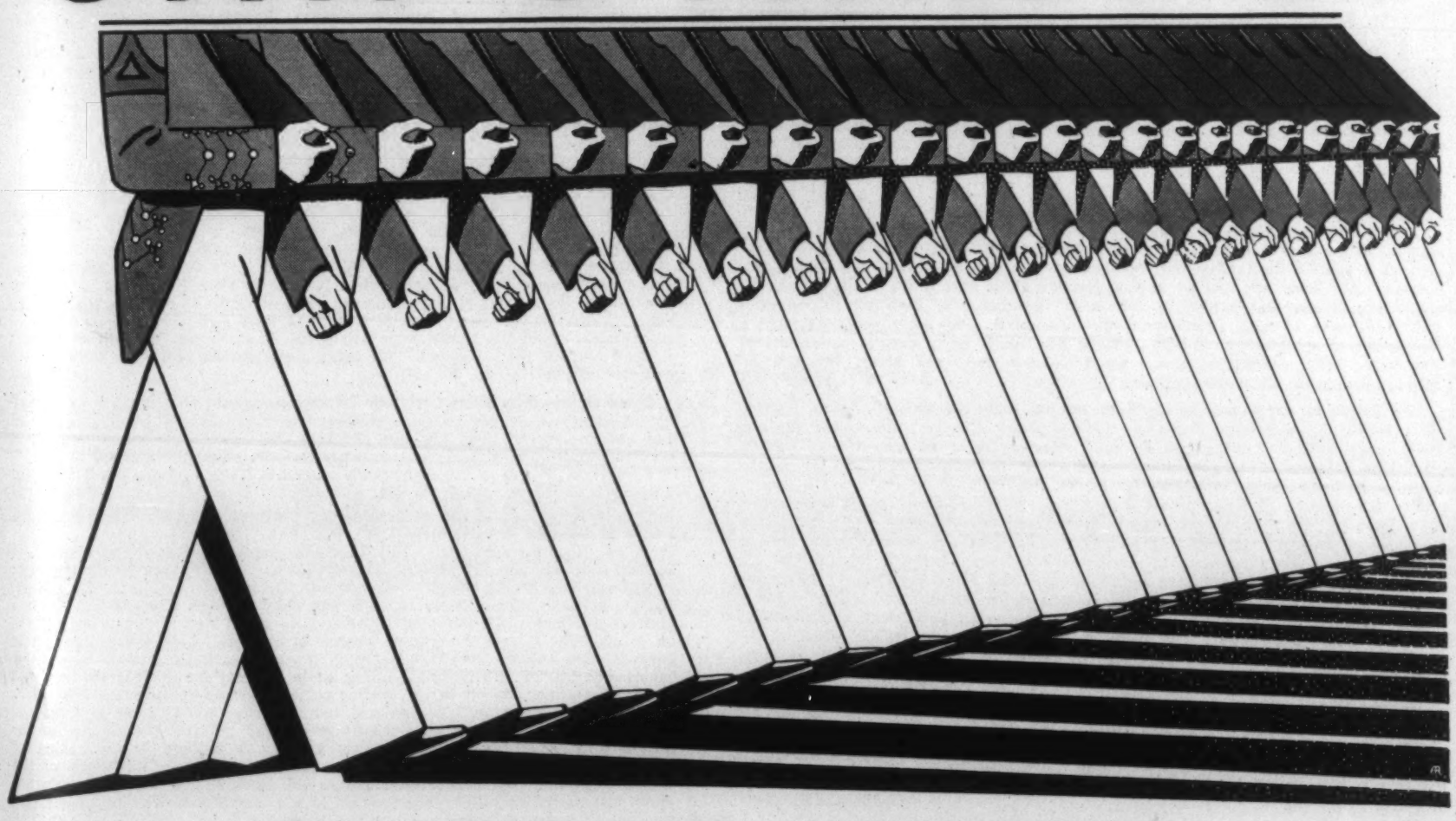

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EFFECT OF TEMPERATURES ON METALS AND ALLOYS (12)

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

L. JORDAN, SECTION EDITOR

The Mechanical Properties of Metals at Low Temperatures. II. Non-Ferrous Metals. E. W. COLBECK & W. E. MCGILLIVRAY. *Metal Industry*, London, Vol. 43, Dec. 15, 1933, pages 579-582. Commercial specimens of duralumin, elektron, Cu, Ni and German silver were tested at temperatures from + 20° to — 180° C. An increase in ductility was found at — 180° C. for almost all materials tested. Cu-Ni alloys show the greatest improvement in elongation values between — 120 and — 180°. German silver shows a definite increase in ductility between 20 and — 180°, elongation steadily increases down to — 80° with a still greater improvement between — 80° and — 180°. Results of tensile strength and impact tests confirmed previous results of other investigators. Increase of tensile strength of Al bronze was about 24.5% in the range from 20 to — 180°, but a marked deterioration in ductility was found. 12 references. Hap (12)

Toughness of Alloy Steels at Low Temperatures. JOHN J. EGAN, WALTER CRAFTS & A. B. KINZEL. *Metal Prorgess*, Vol. 24, Sept. 1933, pages 18-20. Izod impact strengths at low temperatures were determined for several S. A. E. steels (Ni, Cr-Ni and Cr-V), a few special low-alloy steels (3% Cr, Cr-Mn-Si, Zr and Cu-Cr), and plain carbon steels (0.20 to 0.80% C), all in normalized condition. Impact values of the carbon and low-alloy steels fell rapidly between 0 and —100° C. Between —100° and —183° C. little further decrease occurred. Below —100° C. austenitic rather than the normalized low-alloy steels should be used for resistance to impact. In the range 0 to —80° C. Zr steels had higher and more consistent impact strengths than the other low-alloy and the carbon steels studied. WLCp (12)

Heat-Resisting Cast Irons. E. MORGAN. *Foundry Trade Journal*, Vol. 49, July 20, 1933, pages 31-34; July 27, 1933, page 47. After dealing with the subject of the growth of cast iron, particularly with factors promoting growth, attention is paid to the fundamental requirements for growth-resistant gray iron. Heat-resisting cast irons are divided into 4 groups: white cast irons, low-silicon irons, high-silicon irons, and austenitic cast irons. Resistance of cast iron to corrosion and to stresses at high temperatures are considered. The paper concludes with a description of applications of heat-resisting cast irons, as in furnace parts, firebars and stoker links, carburizing boxes, metal and salt pots, and molds. The paper is accompanied by a useful bibliography. OWEp (12)

The Effect of Time and Temperature on the Embrittlement of Steels. A. M. KAY & R. N. ARNOLD. *Iron & Coal Trades Review*, Vol. 127, Oct. 6, 1933, page 517. "Age embrittling," occurring in steels subjected to working conditions at elevated temperatures, reveals itself by reduced resistance to shock. Methods of investigating this phenomenon are described; the ultimate embrittlement produced by soaking at temperatures from 300° to 650° C. is apparently independent of temperature, but the rate at which the change occurs increases with increasing temperature. Working stresses play no apparent part in the embrittlement. Serious embrittlement is likely to occur in steels which contain about 3% Ni and 1% Cr. Mo up to 1.5% acts as retarding agent but does not affect the ultimate embrittlement. Impact resistance is considerably lowered while hardness and tensile strength during embrittlement vary but little. The structure, even under high magnification, does not change appreciably. The cause of this embrittlement is still doubtful. It seems possible that the slight solubility of cementite (Fe_3C) in ferrite increases with temperature and causes sub-microscopic structural changes. Hap (12)

Internal Combustion Engine Exhaust Valve Failures. C. C. HODGSON. *Iron & Coal Trades Review*, Vol. 126, May 5, 1933, pages 695-698; *Heat Treating & Forging*, Vol. 19, Nov. 1933, pages 67-69, 73; Dec. 1933, pages 96-99; *Engineering*, Vol. 135, May 26, 1933, pages 580-581. Paper read before the Iron & Steel Institute, May 1933. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 369. Ha+MS+LFMp (12)

Design and Performance of Heat-Resisting Alloy Castings. ROLF S. COCHRAN. *Iron Age*, Vol. 130, Nov. 24, 1932, page 804. See *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 369. VSPp (12)

The Properties of Metals for High-Temperature High-Pressure Engineering, Part II. J. H. G. MONYPENNY. *Iron & Steel Industry & British Foundryman*, Vol. 6, Feb. 1933, pages 179-182. Several specific examples of problems encountered in selecting proper materials for boilers and oil-cracking plants are given. Use is made of published creep strength data on steels to emphasize their desirability for specific purposes. CHLp (12)

Embrittlement of Steel at High Steam Temperatures. H. A. DICKIE. *Engineering*, Vol. 136, Aug. 4, 1933, pages 108-109. Steels heated at temperatures in the neighborhood of 450° C. exhibit a progressive loss of toughness, which in practice leads to the failure of stud bolts and other high temperature equipment. Steels containing small quantities of nickel and chromium together, or with 2 to 3% manganese alone, are more susceptible to this form of embrittlement. This susceptibility points to a similarity between brittleness of this kind and the phenomenon usually denoted by the term temper-brittleness. Embrittlement at the temperatures of superheated steam develops over longer periods and at lower temperatures in steels which are free from the ordinary form of temper-brittleness. Stress as an accelerating factor is important, but steels will also become brittle in the absence of externally-applied stress. Former studies have indicated that the changes taking place in so-called temper-brittleness are concerned with the solution and deposition of carbide in the ferrite of the steels, this conclusion being based on the changes in specific volume and hardness. A review of hardness, specific volume, electrical resistivity, together with magnetic properties and ease of solution confirm the conclusion that carbon is the controlling factor. High chromium steels show some tendency to develop temper-brittleness, although the carbide solubility changes are relatively very small. Experimental data now point to the fact that any steel showing solubility changes, as judged by magnetic or resistance methods, will be liable to embrittlement given suitable conditions of temperature and time. The double change in specific volume and in hardness observed in connection with temper-brittleness is believed to be due to the manner of separation of carbide from solid solution. When it separates in a fine state of division within the grains, the steel contracts and softens and does not become brittle. When it is expelled to the grain boundaries, a hard, brittle network is formed, making the steel weak in the notched-bar test. The carbide network increases the resistance to penetration, thus making the steel harder than when the carbide is in granular form. If the carbides are spheroidized, further heat treatments will not produce appreciable embrittlement. Experiments on chromium-nickel steels are detailed, in which various heat treatments were made and subsequent hardness tests recorded to determine the condition of the carbides in the grains. Molybdenum, while assisting in the prevention of temper-brittleness, will not prevent long-time embrittlement but will minimize it. LFMp (12)

Influence of Temperature on the Mechanical Properties of Brass (L'influence de la température sur les propriétés mécaniques des laitons) K. BRONIEWSKI & K. WESOLOWSKI. *Revue de Métallurgie*, Vol. 30, Sept. 1933, pages 396-401; Nov. 1933, pages 453-457. Physical properties of brasses containing 33% Zn, 40% Zn and 40% Zn + 1.3% Pb were determined using methods developed by Krupkowski (*Revue de Métallurgie*, Vol. 28, 1931, pages 529-, 598-, 641-, Vol. 29, 1932, pages 16-, 74-). Tests were made over the temperature range —200° to 700° C. Curves representing the changes in tensile strength, elastic limit and hardness with temperature are of a similar shape for three brasses tested. Their drop is faster at low temperatures and near the recrystallization zone. Reduction of area and elongation for 40% Zn brass show two minima, in the recrystallization zone, about 350° C., and between 500° and 600° C. 30% brass does not show any discontinuities and a minimum at 300° C. can be seen only on strained metal. In 33% Zn brass impact strength reaches a maximum at —80° C., rapidly drops in the recrystallization range having a horizontal section between 100° C. and 200° C. and a minimum at about 500° C. In 40% Zn brass the low temperature maximum flattens, the horizontal portion disappears and the rapid drop in the recrystallization range is followed by a large minimum and a pronounced maximum around 650° C. The presence of Pb eliminates the latter. The effects of cold work do not exert any influence on 33% Zn brass above 400° C. In 40% brass its effects are not felt above 600° C., while the addition of Pb lowers this limit to about 500° C. JDGp (12)

Hot-Shortness in Copper-Bearing Steels and Its Prevention. (Die Rotbruchigkeit Kupferhaltiger Stähle und ihre Vermeidung) F. NEHL. *Stahl und Eisen*, Vol. 53, July 27, 1933, pages 773-779. The hot-working properties of low-carbon steels containing from 0.19 to 1.52% Cu were studied by means of bend tests of heated plates 20 mm. thick. In the temperature range 800°-1000° C. no red-shortness was encountered even with the steel containing 1.92% Cu. Above 1100° C. cracks appeared at the outsides of the bends in the steels containing more than 0.5% Cu. Metallographic studies indicated the following explanation. On heating, the Fe in the steel is preferentially oxidized at the surface leaving a thin layer of Cu beneath the scale; this Cu layer when heated above its melting point penetrates the steel along grain boundaries. Such intercrystalline penetration by the Cu causes surface red-shortness during severe deformations. The red-shortness may be partly overcome by preventing preferential oxidation of the Fe, i.e., by heating in a reducing atmosphere. This recourse alone was not successful, however, in high-temperature piercing operations of seamless tubing. On the other hand, the addition of about half as much Ni as Cu overcame hot-shortness even in such cases. The explanation given is that the alloyed Ni raises the melting point of the Cu-Ni layer formed underneath the scale and also decreases the tendency toward intercrystalline penetration of the Cu-Ni layer even after it is melted. The Ni additions raised the tensile properties of the Cu steels, so that high values were obtained without heat treatment. The aging characteristics of the Cu-bearing steels were not affected by the Ni additions. SEp (12)

Study of Growth in Alloy Cast Iron (Wachstumsversuche mit legiertem Gussiesen) T. MEIERLING. *Archiv für das Eisenhüttenwesen*, Vol. 7, Aug. 1933, pages 141-143. Cr, Ni, and Mo were added to gray cast iron to secure strength at elevated temperatures without deterioration with time, especially in regard to growth. The best cast iron for these requirements contained 3.1% C, 1.4% Si, 1.1% Mn, 0.6% Cr, 0.6% Ni, and 1.0% Mo. SEp (12)

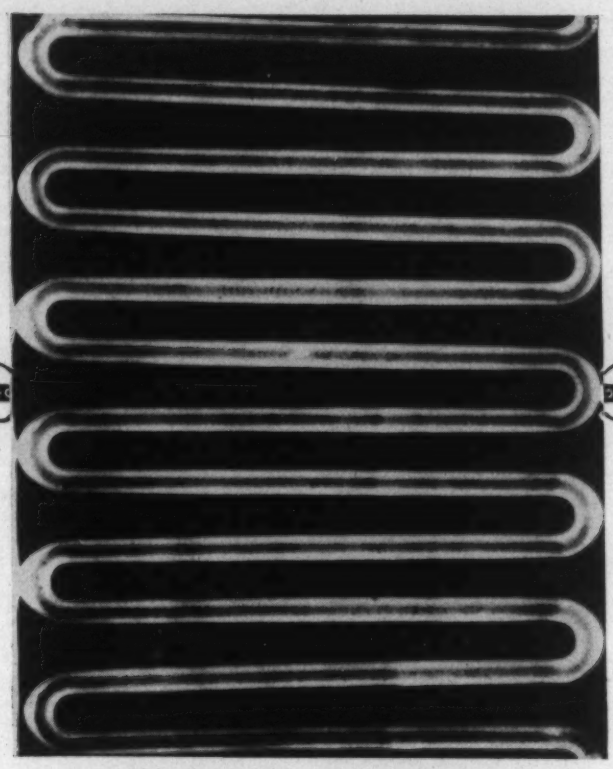
The Effect of the Addition of Lead on the Hardness of Certain Tin-Base Bearing Alloys at Elevated Temperatures. J. N. KENYON. *Proceedings American Society for Testing Materials*, Vol. 33, 1933, pages 430-444; *Metal Industry*, London, Vol. 43, Nov. 17, 1933, pages 493-498. The alloys investigated were No. 1—Sn 80, Sb 15, Cu 5%; No. 2—Sn 89, Sb 7.5, Cu 3.5%; No. 3—Sn 91, Sb 4.5, Cu 4.5%. Pb up to 14% was added to these alloys and the Brinell hardness determined. The addition of 4% Pb to alloys Nos. 1 and 2 and of 3% Pb to alloy No. 3 gave the greatest increase in hardness for all temperatures up to 100° C. The addition of 8% Pb gave an increased hardness at room temperature but none at 100° C. No important falling off in hardness due to these additions was found for temperatures up to the melting point of the Sn-Pb eutectic (183° C.). Hardness-temperature curves for Sn-base bearing alloys are parabolic in form and when plotted to logarithmic scale predict with a fair accuracy the hardness of the material for higher temperatures. Greater accuracy is attained in the making of hardness determinations if a load is chosen that well not cause "cratering" of the Brinell impression. Hardness values obtained with loads of 250 and 500 kg. do not differ materially except for a range of Brinell impressions showing appreciable "cratering" under the higher load. Ha+VVK (12)

The Effect on Various Steels of Hydrogen at High Pressures and Temperatures. N. P. INGLIS & W. ANDREWS. *Iron & Steel Institute, Advance Copy* No. 9, Sept. 1933, 15 pages; *Iron & Coal Trades Review*, Vol. 127, Sept. 15, 1933, page 387; *Foundry Trade Journal*, Vol. 49, Sept. 21, 1933, page 165. Pipes containing H under a pressure of 250 atmospheres were heated to as high as 500° C. for periods of several thousand hr. The inner sections were examined by microscopic means and by mechanical tests in order to detect deterioration resulting from H. At high pressures H attacks steels at much lower temperatures than at lower pressures. Two stages of attack can be distinguished. In the first deterioration is due solely to the absorption of H and the microstructure is unchanged. In the second it is due to decarburization and the effect is readily visible under the microscope. Both the composition and the structure of the steel influence the degree of attack. The rate of attack decreases as the structure becomes finer. Ni-Cr, Ni-Cr-Mo, Cr-V, and Cr-Mo steels were more resistant than plain mild steel. For alloy steels of the structural type the temperature at which the rate of attack was insignificantly small was between 300 and 350° C. For plain C steels this temperature may be as low as 200° C. A 3% Cr steel had a high resistance to attack. An austenitic Cr-Ni steel was very resistant to H attack. 7 references. Ha+OWE+JLG (12)

Electric Conductivity of Mercury at High Temperatures (Die Elektrische Leitfähigkeit des Quecksilbers bei hohen Temperaturen) W. BRAUNBECK. *Zeitschrift für Physik*, Vol. 80, Jan. 1933, pages 137-149. The electric conductivity of Hg was determined for temperatures up to 900° C. and 300 atmospheres. The conductivity, referred to that at 0° C., is linear only up to about 350° C. and then decreases more slowly. From 0° to 900° C. the relative conductivity decreases from 1 to 0.31 at 300 atmospheres. Ha (12)

Advocate Coarse Grain Steel for Gear Forgings. *Iron Age*, Vol. 130, Nov. 17, 1932, pages 755-793. See "Dense Gear Forgings are Machinable and Durable," *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 262. VSP (12d)

109° Below Zero. An Ideal Temperature for Certain Metal-working Operations. *Machinery*, London, Vol. 41, Mar. 30, 1933, pages 757-760. General discussion of "dry ice." By means of sectional drawings the dry ice refrigerator is discussed in which cylinder liners are contracted—they shrink about 0.006 in. in diameter—before slipping them into cylinder bores. Tests show that 3000-5000 lb. of pressure are necessary to force a liner from its bore. Before each liner is placed in the refrigerator, it is immersed in thin oil—a mixture of light dynamo oil with 50% of paraffin—to protect it against hoar-frost. To prevent aging of Al-alloy rivets after heat treatment they are placed in dry ice refrigerators in which they are kept at temperatures from 20-40° F. below zero. Tests made on Cr-Ni, Ni-Si, and other corrosion-resisting steels have shown that certain steel alloys can be hardened appreciably by cooling them to low temperatures. The alloys were hardened without discoloration, unusual physical and corrosion-resisting properties were developed, and machinability was improved in some cases. The procedure followed in making such tests is summarized. Kz (12)



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CORROSION AND WEAR (13)

V. V. KENDALL, SECTION EDITOR

1 **Internal Stresses and Wear Resistance of Rails (Eigenspannungen und Verschleisswiderstand von Schienen)** M. SPINDEL. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 88, Jan. 1, 1933, pages 10-16. Paper before Second Rail Meeting, Zürich, 1932. The internal stresses partly due to the perpetual cold working of the rails by the wheels are determined by a new method of the author who gradually saws off several mm. thick layers and who determines the changes in length up to .001 mm. The increase in tensile strength does not necessarily mean a gain in wear resistance. The purity of the steel employed is stressed and the adoption of adequate wear tests instead of tensile tests is urged. The pressure should be raised to 10 kg. in these wear tests and the sliding velocity lowered to 20 m./min. Under these testing conditions, the old Bessemer rails no longer exhibit their superiority. The wear of some 13 rails is graphically presented including Bessemer, open hearth and electric steel rails. Tests show that results vary greatly according to sliding velocity. EF (13)

2 **The Protective Action of Zinc Plates in Boilers.** C. O. BANNISTER & R. KERR. *Metal Industry*, London, Vol. 41, Nov. 4, 1932, pages 441-443; Nov. 11, 1932, pages 467-470. The electrochemical reasons for the protection which Zn plates or other Zn material offers to the Fe or steel of boilers are discussed and the reasons for the limited protection explained. Methods of determining the action are described and results of tests with different attacking mediums given in detail. It is concluded that Zn cannot protect steel in normal boiler practice by electrolytic action but does perform a useful function by purely chemical means; i.e. by simple oxidation. 1 ft. of Zn surface is generally considered to protect 50 ft.^{2} of Fe or steel; the Zn plates used have a surface area of ½ ft.^{2} and weigh 4000 g.; they are consumed in about 120 days. Ha (13)

3 **Plating Metallic Laboratory Ware for Resistancy.** SOL. A. BERNSTEIN. *Chemist-Analyst*, Vol. 21, July 1932, page 5. Crucible tongs, tweezers, spatulas, etc., can be gold plated to resist corrosion and chemicals by plating in 2% $Au(CN)_3$ solution with 2 dry cells for about 3 minutes. CEM (13)

Soil Corrosion of Pipe Lines. (Über die Erdbodenkorrosion von Rohrleitungen.) K. ADLOFF. *Die Wärme*, Vol. 55, Oct. 8, 1932, pages 710-711. Sources of corrosion in pipe lines in the ground. Difficulties encountered in investigating the causes and determination of their origin. Regulations for protection by applying testing methods to pipe lines installed. Measurement of currents in the soil and representation of their course. Instructions for employment of protective means. EF (13)

4 **Solution Speed of Carbonyl Iron in HCl and H_2SO_4. (Die Geschwindigkeit der Auflösung des Carbonyleisens in Salz- und Schwefelsäure.)** M. CENTNERZWER & M. STRAUMANIS. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 162, Oct. 1932, pages 94-102. Since the corrosion stability of metals increases with their purity, the writers experimented with the "purest Fe available at present," i.e. with carbonyl Fe. No essential attacks were noticed in both diluted acids. Even in 10-11.45 N (conc.) HCl, carbonyl Fe dissolves but sluggishly. After an induction period of several days, a final velocity of 13-17 mm.^{3} H_2/min./cm.^{2} Fe is attained. One or several outbursts of increased solution speeds are noticed. The attack of H_2SO_4 is more pronounced than that of HCl of the same normality and approaches a final dissolution at a rate of 20-24 mm.^{3} H_2/min. for 6-10 N H_2SO_4. Otherwise the solution process in both acids is very similar only the induction periods are shorter and the reaction accelerations attain larger values in case of H_2SO_4. The abrupt increase of the dissolution and partly the final velocities, too, are ascribed to traces of foreign matter (C) in carbonyl Fe. EF (13)

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Economic Significance of Corrosion Protection. (Die wirtschaftliche Bedeutung des Korrosionsschutzes.) E. Asser. *Farben Zeitung*, Vol. 38, Oct. 15, 1932, page 66. Some statistic data on corrosion losses are given and the insufficient corrosion protection of German bridges is criticized. EF (13)

Investigates Corrosion of Welds in Specially-Built Testing Device. *Steel*, Vol. 91, July 25, 1932, page 30. Description of apparatus for subjecting welded test specimens alternately to the air and to corroding liquids for definite periods of time to hasten the rusting process. JN (13)

Corrosion in Boiler Water Pipes. (Korrosionen an Speisewasserleitungen. Betriebserfahrungen.) H. Sch. *Brennstoff und Wärmewirtschaft*, Vol. 25, Apr. 1933, page 66. Corrosion defects are ascribed to the presence of gases dissolved in the boiler water. Cu pipes installed instead of the original steel pipes yielded good service. Cast steel sluice valves and branch pipes were not replaced but also showed heavy corrosion defects at the occasion of a later general overhauling. The writer recommends the installation of a degasification apparatus as the surest remedy. On account of the high expenses involved, Cu plating of the cast steel members was tried and found to be most successful. Heavily corroded parts were advantageously replaced by a Zn-free bearing bronze. EF (13)

Corrosion of Iron Alloys by H_2S. (Korrosion von Eisenlegierungen durch Schwefelwasserstoff.) *Die Wärme*, Vol. 55, Nov. 5, 1932, page 768. Refers to experiments of White and Marek on corrosion tests with moist and dry H_2S on various steels and cold rolled Al. While Al was not corroded after 3 weeks, the steel samples became the more resistant the higher the Cr content over the range from 0-25.7% Cr. The sulphide film did not furnish a protective coating against further corrosion attack. EF (13)

Iron Destruction by Water. (Eisenzerstörung durch Wasser.) *Die Wärme*, Vol. 55, Nov. 26, 1932, pages 824-825. The 3 main types of destruction of Fe due to rusting are considered (1) pitting, (2) uniform corrosion advance and (3) "sponginess" due to eddy currents and furthermore promoted by the presence of CO_2 and O_2 in the water. The latter holds also for (1) and (2). One effective countermeasure is stressed: the removal of the detrimental gases by high vacuum. EF (13)

Combating Corrosion on Gasworks. *Gas Engineer*, Vol. 57, June 1932, pages 298-299. Pumps for handling acid liquors. Materials referred to are 18/8 and Fe-Si alloys. WH (13)

Procedure for Bonderizing Steel. *Heat Treating & Forging*, Vol. 18, Oct. 1932, pages 593-594, 600. Describes equipment and methods used by the Chrysler Motor Car Company at the Plymouth and DeSoto plants for "Bonderizing" and japanning sheet steel parts. "Bonderizing," a rust-proofing process, consists of dipping the parts in H_2O solution of Mn and Fe phosphates at 210° F. Butane is used for firing the ovens. MS (13)

Metallurgical Problems Arising from Internal-combustion Engine Valves. *Mechanical World & Engineering Record*, Vol. 92, Nov. 25, 1932, page 509. Troubles arise by the increasing use of tetra-ethyl lead in fuel. The austenitic valves with a high Ni content appear to be most resistant to corrosion of this type, although when these valves are heated above 600° C. a deposition and rearrangement of carbides occur which appear to be identical with the changes which give rise to "weld decay" in the low-carbon austenitic steels. Kz (13)

Influence of Impurities on the Corrosion Resistance of Zinc. (Der Einfluss einiger Verunreinigungen auf die Korrosionsfestigkeit des Zinks.) *Die Metallbörse*, Vol. 22, June 11, 1932, pages 738-739. Exceedingly pure Zn shows a remarkable resistance even against HCl. Low amounts of Fe, Pb, Cd, Ca and Sb affect the stability of Zn in saturated room atmospheres but slightly. Pb is supposed to exert a beneficial effect even in outdoor corrosion attack which is promoted by Cu and Sb (0.007%). The role of As is dubious, while Cd and Fe are indifferent. Except Fe, the same effects of contaminations in acid solutions are noticed as is the case in atmospheric corrosion. A diagram is presented showing the corrosion losses in 0.5% H_2SO_4 due to the presence of Sb, Fe, Cu, Cd and Pb. EF (13)

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Methods of Preventing Silver from Tarnishing (Über die Verhinderung des Anlaufens von Silber) FRITZ MARKHOFF. *Sprechsaal für Keramik, Glas, Email*, Vol. 66, June 1, 1933, pages 370-371. Since Ag tarnishes while being used it has been replaced in recent times by rust resistant steel. Discusses various methods of protecting metal from staining. This can be attained either by using
1 Ag alloys instead of the pure metal, or covering the metal with an alloy. Among such constituents are mentioned: Sn, Al, Ca, Mg, Bi, Ba, Zn and others. Other methods are those of coating the metal with protective layers. Various methods and solutions used are considered, as solutions of persulphates, copper ammonia chloride, chromic acid, etc. Dipping time about 1 min. The protective layer is absolutely invisible. Electrolytic methods of passifying Ag are mentioned. GN (13)

Safety Drilling. JOEL H. HIRSCH. *Refiner & Natural Gasoline Manufacturer*, Vol. 12, May 1933, pages 184-188. Method developed by Luis de Florez & Co. of drilling a moderate number of small holes in boiler and cracking still tubes at point where greatest corrosion is likely to occur is described. Method is devised as a safety device to foretell tube failures and thereby prevent serious explosions. Briefly method consists of drilling series of ⅛" holes ½ way
2 through wall of tube. Tests show that these do not weaken tubes. In fact data presented on hydrostatic bursting tests shows that of 3 C steels tested all gave higher bursting pressures on tubes that had been drilled as compared with tubes that had not been drilled. Method has proven extremely satisfactory. WAT (13)

Corrosion Fatigue of Light Metals. F. HORN. *Mechanical World & Engineering Record*, Vol. 93, Feb. 24, 1933, page 167. Research has shown that ferrous materials, remaining unbroken after 10 million reversals under cyclic stress, will withstand that stress more or less definitely. There is no such limit for light metals. Cyclic stress increases corrosion and this in turn accelerates fatigue. An important factor is the nature of the surface. Stressless corrosion involves diffusion of the negative ions inward and the metal ions outward through the film.
3 Stress increases the permeability of the coating. Steady stress increases the permeability temporarily because the increased diffusion of ions fills up the enlarged pores. In case of alternating stress the increase of porosity and the rate of net damage depends on the range of stress. Kz (13)

Corrosion of Light Metals. F. HORN. *Mechanical World & Engineering Record*, Vol. 93, Jan. 27, 1933, pages 75-76. Al is chiefly alloyed with Cu, Si, Zn, Mg, Mn and Ni in the approximate order of their importance. Mg is mainly alloyed with Al or Mn, with small additions of other metals. The oxide film shows mechanical strength and abrasion resistance. Corrosion may be divided roughly into 3 main classes: (1) general corrosion, at the surface, (2) pitting, (3) inter-crystalline corrosion, along the grain boundaries. Recent research indicates
4 that the corrosion does not necessarily take place at the crystal boundaries, but may occur at the slip planes of the crystals themselves. Alloys of Al with compounds insoluble or partly insoluble in the base metal are more likely to be subject to corrosion by reason of differences of potential set up between the base metal and such intermetallic compounds. Discussing the relation between corrosion and composition of metal, it is said that of the straight binary alloys, those containing some 12% Si (eutectic composition) and those with up to 2% Mn are the most resistant to corrosion. Possessing no high mechanical properties it usually becomes necessary to employ a ternary or still more complicated alloy. Influence of small additions of rare metals on the resistance to corrosion of high-duty alloys has been studied. Kz (13)

Corrosion Testing of Light Metals. F. HORN. *Mechanical World & Engineering Record*, Vol. 93, Feb. 10, 1933, pages 126-127. Attention is
5 called to the International Propaganda Bureau formed by the European Al producers to study every question connected with Al and its alloys. This bureau has drawn up a standard corrosion test procedure, issued in form of a memorandum, which is discussed in the article. Two kinds of tests are available: (1) one being superaccelerated for rough comparisons only, (2) lengthy field tests are the most valuable, but in order to obtain results quickly, some methods of correlating short-time tests with service conditions has yet to be found. The thermal hydrochloric acid test measures the temperature rise of a test-piece immersed in HCl. In the gas volumetric test results are expressed in cc. of H_2 developed/hour/cm.^{2} of
6 metal. The salt-spray test and the alternate immersion test are criticized. To investigate effects of corrosion test pieces are subjected to mechanical tests. Kz (13)

Prevention of Corrosion in Light Metals. F. HORN. *Mechanical World & Engineering Record*, Vol. 93, Mar. 10, 1933, pages 242-243. On account of the high coefficient of expansion of Al alloys, protective coatings, used on steel surfaces, are insufficiently elastic for light alloys. Linseed oil, owing to its great flexibility, has proved itself the most suitable medium. Research has been concentrated on discovering means of making the surface non-corrosive by:

Metallizing	Spraying or Rolling
Plating	Zn or Cr
Oxidizing	Chemical or Electrical

Pure Al being highly corrosion resistant, protection of alloys was attempted by
7 spraying them with pure Al. More successful is the production of a thin layer of pure Al rolled into the surface of duralumin during manufacture, and heat treated with the latter. Modifications of this principle are discussed. Zn and Cr can be successfully plated on Al. Zn has been found to give limited preferential protection, pure Zn being under most conditions slightly electro-positive to duralumin. Processes of oxidizing are dealt with, the most successful being called the Bengough or anodic process in which a 3% aqueous solution of chromic acid at 40° C. is used. The article to be coated is the anode and the steel tank the cathode and the voltage is gradually raised from 0-50 volts over a period of one hour. Application of grease (lanolin, etc.) improves the protection causing hy-
8 drolizing. Other processes involve the use of sulphuric acid or oxalic acid. The covering consists essentially of the hydrated oxide of Al in a hard and dense form, with traces only of the salt used as electrolyte which influences the power of the film to absorb coloring media. Kz (13)

Measurement of Degree of Polish to Determine Corrosion Behavior of Stainless Steels. (Sur la mesure du degré de poli en vue de la détermination de la tenue à la corrosion des aciers inoxydables.) JEAN COURNOT & LOUISE HALM. *Comptes Rendus*, Vol. 196, Apr. 3, 1933, pages 1017-1019. Resistance of stainless steel to corrosion is dependent upon its degree of polish. In order to determine the degree of polish produced by various abrasives, a photoelectric cell, suitably standardized, is used to measure the intensity of light scattered at 45° from the metallic surface, the incident light being normal to the surface. A table gives the results found for various abrasives. OWE (13)

Corrosion of Condenser Tubes. (Anfressungen an Kondensatorrohren.) N. CHRISTMANN. *Die Wärme*, Vol. 55, Oct. 1, 1932, pages 689-691. Metallographic
9 and chemical investigation into failure of brass condenser tubes provided with a tin coating disclosed the following causes: formation of local elements between brass and Sn due to an insufficient coating; further removal of Sn coating due to occasional cleaning of tubes with HCl resulting in deep pittings; this was furthermore promoted by presence of CO_2 and O_2 (air) in cooling water. Admiralty brass should be annealed at 350° ± 25° C. in an oxidizing atmosphere and provided with a coherent Sn coating. The tube scale (carbonates) must be removed by soda (30 kg./m.^{3} condenser water) or 5% NaOH solution or HCl including an inhibitor (colloid). EF (13)

Piston and Cylinder Wear in Winter. (Kolben- und Zylinderverschleiss im Winter.)
10 J. CLEMENTSON. *Deutsche Motorzeitschrift*, Vol. 9, Dec. 1932, page 230. Extensive wear of cylinders and pistons in more recent engines is ascribed to higher compression applied, larger speeds and to inadequate lubrication devices. Latter deficiency shows up to a more pronounced extent in winter. When upper parts of piston are running dry a greater wear results in this short time before heating up than after hundreds of miles under normal conditions. EF (13)

APPLICATIONS OF METALS AND ALLOYS (14)

Non-Ferrous (14a)

G. L. CRAIG, SECTION EDITOR

Aluminum for Electrical Construction. (L'aluminium dans le matériel électrique.) N. HUBERT. *Revue de l'Aluminium et de ses applications,* Vol. 9, May-June 1932, pages 1729-1740. Description of the application of Al and Al alloys in the electrical industry brought about by their excellent properties such as low density, high electrical conductivity (35 mhos for pure Al and 22 mhos for a Cu or Si alloy), good thermal conductivity, non magnetic properties, ease of casting and fabrication and resistance to corrosion and chemical attack. AH (14a)

Wheels of Magnesium Alloys. (Les roues en alliage de magnésium.) A. DUMAS. *Revue de l'Aluminium et de ses applications,* Vol. 10, Mar.-Apr. 1933, pages 2035-2042. Mg alloy wheels are light and strong. For busses, trucks and tramways Mg alloys for wheels have brought a substantial decrease in weight with excellent working conditions. AH (14a)

Transportation of Liquids by means of Light Alloy Tanks. (Les alliages légers et le transport de liquides en citernes.) A. DUMAS & R. KAUFFMANN. *Revue de l'Aluminium et de ses applications,* Vol. 10, Mar-Apr. 1933, pages 2017-2026. Tanks made of light alloys have as good working characteristics as steel tanks and their carrying capacity is 20% higher. The cost of one light alloy tank is about twice that of a steel tank but the difference is paid in 6 to 8 months (for regular use) by the economy brought about in maintenance and operation. AH (14a)

Use of Nickel for Mining. (De l'emploi du nickel dans la construction du matériel de mines.) L. FONTAINE. *Revue du Nickel,* Vol. 4, Apr. 1933, pages 46-64. A detailed description of the uses of nickel for mining. The compositions of the various alloys and their properties are given. AH (14a)

New Heat Insulating Materials. A. L. FORSTER. *Mechanical World & Engineering Record,* Vol. 93, May 26, 1933, pages 504-506. The properties of glass and Al as heat insulators are discussed. "Alfol" is a very light material, the actual Al foil weighing about 3 oz./ft.^{2}, which is enclosed by a self-supporting protecting shell. The insulation operates by combining the low conductivity of the air spaces between the layers of crumpled Al foil with the heat reflecting power of the bright metal surfaces, thus reducing loss by convection and radiation. Conduction loss owing to the fact that the layers touch only at intervals, is said to be negligible. Advantages besides light weight are: Cleanliness, non-inflammability, and low heat-storage capacity. A new method of determining heat loss from insulation is discussed. Kz (14a)

Consideration of Light Metals from Commercial and Engineering Standpoint. (Materialtechnische und konstruktive Behandlung von Leichtmetall.) W. FARGES. *Metallwirtschaft,* Vol. 12, Feb. 3, 1933, pages 59-62. In considering use of light metals these points should be investigated: 1. What is commercial advantage of using a light metal? 2. Will article be made from a sand, permanent mold, or die casting, or by pressing, forging, drawing or forming? 3. What are nature and magnitude of stresses? 4. Will article be subject to corrosion? 5. With what other materials will article be assembled? Whether article is to be made from a casting or rolled material depends on several factors such as shape, cost, quantity to be made and tolerances. A large number of cheap, strong or corrosion resistant Al casting alloys is available from which to choose according to the requirements. Wrought alloys are divided into 4 groups: 1. Pure Al with good corrosion resistance but low strength, 2. Al alloys with good corrosion resistance and intermediate strength, 3. High strength alloys with poorer corrosion resistance and 4. The clad materials, consisting of high strength alloys with a surface layer of pure Al for corrosion resistance. The designer should give due consideration to factors of safety. The higher strength heat treated wrought alloys can be considered in the same light as heat treated steel, except that they have a much lower modulus and impact strength. Light metals can be soldered, welded and riveted, with certain restrictions. Heat treated alloys should not be welded. CEM (14a)

Fusible Tin Plugs. C. S. DARLING. *Mechanical World & Engineering Record,* Vol. 91, Apr. 8, 1932, page 337. Failure of many plugs to operate at the desired time, has frequently been ascribed to the formation of a hard infusible crust, having a high content of stannic oxide (m.p. 1127° C.) plus magnesium and calcium sulphate (m.p. 1300° C.), on the fire side of the plug. Different causes which might have led to this formation are considered. It is proposed to renew the plug periodically by arrangement with the insurance authorities, and thus guarantee its efficient working. Kz (14a)

Design of Aluminum Alloy Traveling Cranes. E. C. HARTMANN. *Metal Stampings,* Vol. 5, Oct. 1932, pages 595-598. Discusses principles and practices to be followed in the application of Al alloys to the fabrication of traveling cranes. Alloys most often used are wrought alloys 17ST and 3S and casting alloys 12 and 195-16. Parts which are fabricated from structural shapes or plates are made almost exclusively of 17ST. All connections in this alloy are riveted or bolted, no welding being permitted. 3S is used only as sheet or plate for low stressed parts such as gear covers. 195-16 is used for cast parts where strength is important, such as end carriages and trolley frames. 12 is used for low stressed brackets and supports. Design procedure does not differ materially from that used with other materials. There are 15 Al alloy cranes in operation at present. Tabulates mechanical properties and design stresses. MS (14a)

"Hydronalium" Lightmetal. ("Hydronalium"-Leichtmetall.) *Zeitschrift für Flugtechnik und Motorluftschiffahrt,* Vol. 23, Aug. 12, 1932, page 474. An alloy of the I. G. Farbenindustrie A.G. of low density, great strength, and remarkably high corrosion resistance. Alloy is lighter than duralumin and workable at room-temperature. Welded with "Autogal" the weld will show 90% strength of the alloy and 5% ductility. The density is given as 2.63.

Semi-finished products	Yield point kg./mm.^{2}	Tensile strength kg./mm.^{2}	Elong. %
Pressed semi-finished products	15-20	31-35	16-22
Soft sheets	15-18	31-36	16-22
Hard sheets	30-36	30-43	4- 9
Medium sheets	-------	35-40	6-14

Kz (14a)

Application Possibilities for Aluminum. (Anwendungsmöglichkeiten des Aluminiums.) *Aluminium,* Vol. 15, Apr. 30, 1933, pages 1-4. The many purposes for which Al is used in domestic appliances, transmission lines, furniture, cutlery are reviewed. Al-foil has quite generally replaced Sn-foil. The former is made commercially today in thicknesses of 0.005 mm. A few statistical figures on world production and consumption are given. Ha (14a)

Copper in Window Frames and Show Windows. (Le Cuivre dans les Châssis de Fenêtres et l'Aménagement des Devautures de Magasins.) *Cuivre et Laiton,* Vol. 6, Apr. 15, 1933, pages 163-176; May 15, 1933, pages 216-223; June 15, 1933, pages 269-278. A very exhaustive description is made of construction, arrangement, profiles used and available fittings, etc., and numerous examples are shown of buildings in which window frames, sashes, show windows, decorative arrangements and cases are built of Cu or Cu alloys. Ha (14a)

Aluminum as a Heat Insulating Material. *Chemical Age,* Vol. 27, Aug. 27, 1932, pages 191-192. Alfol system of heat insulation consists of concentric layers of crumpled Al foil of .0003" thickness, 3 layers of foil making up about 1" of insulating thickness. It is unaffected by vibration and shows a high efficiency. VVK (14a)

Ferrous (14b)

M. GENSAMER, SECTION EDITOR

1 **Nickel Steels and Alloys for Railways. (Aciers et alliages de nickel utilisés dans les chemins de fer.)** J. GALIBOURG. *Revue du Nickel,* Vol. 3, Oct. 1932, pages 130-144. A very detailed and complete description of the compositions and uses of nickel steels and alloys for railways. AH (14b)

Cast Nickel Steels for General Construction. (Les aciers moulés de construction au nickel.) J. GALIBOURG. *Revue du Nickel,* Vol. 4, Jan. 1933, pages 2-13. Discusses effect of Ni as an alloying element on cast steel and for chains, car wheels, armor steel, rail frogs and crossings, gears, etc. Ni brings about deep hardening of steel and is very beneficial for cast steels. AH (14b)

2 **Steel Buildings of a New Type.** FEDERICO GIOLITTI. *Metal Progress,* Vol. 23, June 1933, pages 42-43. A new type of "tension structure" steel building is described. It consists of a static arrangement of tension members to balance the total weight about one or more central piers specially designed for compression stress. Two-thirds of the members of the structure can be reduced to simple standard units. The central portion is loaded with increasing stress from top to base: the rest of the building being free from weight of the upper floors, all floor frames are identical. Through use of tension rods the weight of metal used is reduced 30% from conventional designs. Absence of outside posts leaves additional ground space free for show rooms. The reduction in foundations gives 50% savings on this item alone. The building field division between reinforced concrete and steel skeleton appears to be upset by the new system. WLC (14b)

3 **Structural Steel in Industrial Maintenance.** FRED D. HARTFORD. *Mill & Factory,* June 1933, pages 29-32. Deals with (1) repairing and strengthening of plant structures and equipment, (2) inspection of new steelwork erected at a plant, (3) estimating of steelwork for repairs, and minor new construction. The article includes the discussion of maintenance tools for working structural steel, steel erection tools for the maintenance department, the strength of steel work, and the effect of temperature on structural steel. Kz (14b)

Canopy of Corrugated Steel Sheets Replaces Canvas Awning. F. D. HARTFORD. *Steel,* Vol. 91, Sept. 12, 1932, page 32. Description of an all-steel canopy consisting of a suspended steel frame fastened to the side of the building and a roof of galvanized corrugated sheets. JN (14b)

4 **The Applications of Various Steels.** L. W. JOHNSON. *Journal Institution of Production Engineers,* Vol. 12, Apr. 1933, pages 123-151; *errata* June 1933, page 266. Includes discussion. The chief characteristics and fields of service of carbon steels, medium alloy, case hardening, corrosion resisting, heat resisting, tool, and miscellaneous steels are described. JCC (14b)

Special Steels for Shipbuilding. W. BENNETT. *Marine Engineering & Shipping Age,* Vol. 37, Mar. 1932, pages 124-126. See "Special Quality Steels for Shipbuilding." *Metals & Alloys,* Vol. 3, July 1932, page MA 214. Kz (14b)

5 **Alloy Steel for General Furnace Use.** T. G. ELLIOTT, R. J. SARJANT & W. CULLEN. *Heat Treating & Forging,* Vol. 18, Dec. 1932, pages 704-707. Paper read before the Sheffield Branch of the Society of Chemical Industry. See *Metals & Alloys,* Vol. 4, July 1933, page MA 208. MS (14b)

Contribution to the Study of the Life of Steel Plant Ingot Molds. (Contribution à l'étude de la durée des lingotières d'aciéries.) JEAN DURAND & JEAN VERNAY. *Journal du Four Eléctrique,* Vol. 42, Mar. 1933, pages 97-98. See *Metals & Alloys,* Vol. 4, Aug. 1933, page MA 254. JDG (14b)

6 **Economical Construction of Complicated Punch-and-die Sets.** A. EYLES. *Mechanical World & Engineering Record,* Vol. 93, Feb. 17, 1933, pages 141-142. Apart from mass of expensive steel used, a one-piece die of any complication means much intricate and costly handwork. The work can be cheapened by the use of alloys of low melting point to form a matrix for holding the various parts of the die together. Another application of these alloys is in molds for pressing compositions of wood and fiber. Physical properties and composition of low melting alloys which have been employed for mounting punch-and-die sets are given. Kz (14b)

Molds for Phenolic Resins. R. A. FISKE. *Mechanical World & Engineering Record,* Vol. 92, Sept. 2, 1932, page 217. **Points to Observe in Making Bakelite Molds.** *Machinery,* London, Vol. 41, Feb. 16, 1933, pages 575-576. Mechanical equipment used in molding bakelite must be of high order, and the quality of the die determines the quality of the molded product. Hardened tool steel is used for the die, and once a mold is made and hardened no more changes can be made. Kz (14b)

7 **High-Test Iron and Steel for Gears.** L. A. DANSE. *Iron Age,* Vol. 130, Sept. 22, 1932, page 463. High-test cast Fe is being substituted for malleable castings in structural parts. Improved heat treatment and improvement in steel itself have made possible the manufacture of gears having higher surface hardness to resist wear and higher tooth strength to resist stresses of service. VSP (14b)

Use of Nickel Steel for the Eyebar Chains Suspension Bridge of Salzinnes, Namur. (Note sur l'emploi d'acier au nickel pour les chaines de suspension de la passerelle de Salzinnes, à Namur.) CAULIER. *Revue du Nickel,* Vol. 4, Apr. 1933, pages 71-73. A description of the Salzinnes bridge and of the composition and mechanical properties of the various alloy steels used. Concludes that the Cr-Ni steels (C 0.35, Ni 3.8 Cr 1.7) will bring forward the use of the eyebar chain for long suspension bridges. AH (14b)

8 **Special Steels for Dredges.** *Chemical Engineering & Mining Review,* Vol. 25, July 5, 1933, page 326. For main driving gears, ladder winch gearing, stacker winch gearing, upper tumbler body, and upper tumbler cushion plates, a Ni-Cr cast steel containing 2.5-3% Ni and .25-.35% Cr was adopted. For screen guide rollers, ladder rollers, screen drive gearing, and spud kick castings, a .5% Ni steel was used. For lower and upper tumbler shaft, screen drive shaft, ladder hoist winch shaft, main brake operating shaft and bucket pins, a 3.5% Ni steel forging was used. The hull and superstructure of the dredges are of mild Ni steel. Buckles and bucket lips have been made of 12% Mn-steel. WHB (14b)

9 **Boiler Drums and Tubes.** C. H. DAVY & C. H. SPARKS. *Mechanical World & Engineering Record,* Vol. 93, Feb. 24, 1933, pages 168-169. For high pressures tube thickness must be a minimum compatible with sufficient strength. The desire to avoid the effect of stresses produced in manufacture has led to the decreasing use of riveted drums in favor of forged drums. A newer development is the production of drums by a metallic arc fusion-welding process. In case of pressures higher than 1400 lbs./in.^{2} special alloy steel has to be taken into consideration. Ni-Cr-Mo steel was used for a boiler suitable for a pressure of 2200 lbs./in.^{2}. Kz (14b)

10 **Modern Metal-Cutting Tools.** J. M. HIGHDUCHECK. *Iron Age,* Vol. 129, May 5, 1932, pages 1010-1013. Often it is not only the quality of the steel itself or the alloys in its composition but the proper treatment of steel that determines whether the best possible use has been made of it. Discusses the various types of forged-steel cutting tools and tip shapes most commonly used. VSP (14b)

Chrome-Nickel Steel Used Extensively in New Gymnasium at Yale. *Steel,* Vol. 91, Aug. 8, 1932, page 26. The many uses found for chrome alloy steels in the new gymnasium and dormitories at Yale University are described. JN (14b)

GENERAL (15)

RICHARD RIMBACH, SECTION EDITOR

Powder Metallurgy—Competes Effectively with Smelting and Machining Processes. CHARLES HARDY. *Engineering & Mining Journal*, Vol. 134, Sept. 1933, pages 373-374. Powder metallurgy is defined as the art of producing metals in finely divided form, the metals so produced being then subjected to mechanical treatment to give them a final or semi-final shape without the aid of the orthodox methods of smelting and machining. The metal may be brought into the powdered state by grinding of ingots, the reduction of the purified oxide in a proper atmosphere, distillation and subsequent condensation, pouring a thin stream of metal through a strong air blast, and the process of depositing pulverulent metal directly by electrolysis. Bi, Cd, Cr, Cu, Fe, Mo, Ni, Ag, Sn, W, and Zn are produced in powder form. Advantages of reconsolidated or compressed metals are: (1) porosity and grain size are under control, (2) metal of highest purity and alloys of constant composition are produced, also alloys and mixtures of metals that cannot be mixed as liquids and mixtures of metals and non-metals such as Cu and graphite for making generator brushes and W and C to form tungsten carbide, (3) the size of the finished part or object may be held to close limits, and (4) manufacturing losses are small due to no slagging, cropping or oxidation, and no trimming. WHBp (15)

Steel Makers. HARRY BREARLEY. Longmans, Green & Company, Ltd., London, 1933. Cloth, 5¾ x 8 inches, 156 pages. Price 5s. Despite its title, this is no collection of biographies of famous steelmill owners. Instead, it is a series of connected essays upon the art of making crucible steel with particular attention to the human element, the ability of the skilled workman to observe and to control the various factors entering into quality, even though he may not be able to express those factors in words.

The author has previously written several books that are universally classed as scientific metallurgy of a superior type, though as he tells us in this volume, he was self-taught, starting his metallurgical education by going to work in a Sheffield steel plant at the age of eleven. From science he has taken what he wanted as he found it, and in his discussion of the art of steel making, he pays full credit to the science of metallurgy. But his is eclectic, he doesn't take anything as so because some "expert" has said it was, he examines it on its own merits.

Admitting that there is something to "body" in tool steel, he does not accept the old idea that it is wholly dependent upon the raw material used for he points out that two ends of a bar may show entirely different "body;" he doesn't think that sulphur has much to do with making steel red-short; he hints that high speed steel may be not as dependent on the tungsten content for its properties as is usually thought and that chromium deserves more attention; his appraisal of the lathe test for evaluating the behavior of a tool steel is most interesting, and that of the Izod test is equally interesting.

His comment on the academic tendency to make courses in metallurgy consist almost wholly of metallography, which he appraises as a valuable adjunct to other methods of evaluation but not a substitute for them, is well taken.

His main theses are that "like all superseding things, in industry as in religion and morals, science in steel making is apt to despise the art it seeks to explain, and, having explained some obvious bit of it, is very likely to believe it understands it," that anyone able to analyze a complex problem into parts that can be dealt with experimentally, has the root of all research qualifications, and that "the voice of authority" is very noisy and apt to be rather useless.

With admission of his own bias and that the book is written primarily to air his own prejudices or preferences, he builds up his case to his final plea for education of a boy by his working in the plant in overalls, whether with or without a formal schooling, but before he is too old to profit most by it, that is, while he is so young that his natural ability to observe has not been cramped and that he is in no danger of starting by looking down on the older workmen. And it is a good case he builds up.

Indeed, the intellectual curiosity and the ability to form independent judgments he wants to keep from squelching by the "voice of authority" are just what a very few modern high schools in the U.S. are trying to foster in curricula that leave the young student great freedom of choice and give him much opportunity to use his hands.

The book is written from the heart, and any book so written is likely to be literature. We pick this as the metallurgical "book of the month" and wish it would be read by all metallurgical educators and all metallurgists, young and old. It should be required reading for seniors and graduate students in all metallurgical courses as a corrective to the point of view they are all too likely to be acquiring, and should be re-read just before the student goes out to his job in industry.

Whether one reads it as a history of the disappearing crucible steel industry, as an argument on metallurgical education, or just as a bit of delightful English, it is worth reading. Few will agree with the author wholly, but all will enjoy it and profit by it. H. W. Gillett (15)-B-

The Romance of Research. L. V. REDMAN & A. V. H. MORY. D. Appleton-Century Co., New York, 1933. Cloth, 5 x 7½ inches, 149 pages. Price $1.00. The subject matter is introduced by an outline of the philosophy of research, as the ability to differentiate between fact and fancy is the first requisite of the research worker.

The chapters on materials will be of particular interest to the engineer and metallurgist. The first of these discusses the role of materials, the second is entitled new requirements and new materials, and the third, the business of inventing new materials. Richard Rimbach (15)-B-

German English Dictionary (Deutsch-Englisches Fachwörterbuch der Metallurgie) HENRY FREEMAN. Otto Spamer Verlag, G.m.b.H., Leipzig, 1933. Fabrikoid, 5 x 7 inches, 327 pages. Price 25 RM. This is Part I of a technical dictionary from German to English, covering metallurgy. The reviewer has checked a number of the words and finds them to be correct. About 25,000 words are given as well as very useful tables of conversion factors, symbols and abbreviations.

As the German-English volume will find its greatest use in English speaking countries the Preface and Introduction should also have been translated into English. Richard Rimbach (15)-B-

Research in Non-Ferrous Metallurgy. E. G. DERECHEY. *Tzvetnuie Metallui.* May-June 1932, pages 21-28. In Russian. A survey of the need of research in non-ferrous metallurgy, and its coordination with the non-ferrous metal industry in the Soviet Union. BND (15)

The Metallurgical Work of the U. S. Bureau of Mines. R. S. DEAN. *Metals & Alloys*, Sept. 1933, pages 137-139. Briefly describes various investigations under study. WLC (15)

Fundamental Laws of Metallurgical Reactions (Die Grundgesetze metallurgischer Reaktionen) W. OELSEN. *Zeitschrift für technische Physik*, Vol. 14, No. 6, 1933, pages 222-226. Metallurgical reactions are chemical transformations in a heterogeneous polymaterial system which take place between the 2 phases metallic melt and slag. The equilibrium of the reactions can be represented sufficiently exactly by the ideal mass law both with respect to its isotherms and its isochores. If any deviations occur they can be traced to the non-ideal behavior of the metallic melt. The less there is a tendency to demixing in melt or slag the more accurately can the behavior be predicted by the mass law; practical metallurgical processes conform to this condition. Ha (15)

Economic (15a)

Economic Importance of Chromium Plating (Die wirtschaftliche Bedeutung der Verchromung) RICH. JUSTH. *Oberflächentechnik*, Vol. 10, Feb. 21, 1933, pages 42-43. Data on general use of Cr plating are given. The great advantages by saving due to reduced wear of base metals, and the properties of Cr to which this is due are discussed generally. Some statistics and the world production of Cr are added. Hap (15a)

Time Studies in Foundry Work. V. BERNARD. *Foundry Trade Journal*, Vol. 49, Aug. 10, 1933, pages 75-78; Aug. 17, 1933, pages 96-98. Author describes 3 series of determinations of the time occupied in executing various operations—(1) molding "gypsy pots" (individual work); (2) molding flat castings on hydraulic machines (executed collectively by gangs of 6 men); and (3) hand haulage over narrow-gage tracks. OWEp (15a)

Profits Through Classified Costs. JOHN L. CARTER. *Foundry*, Vol. 61, June 1933, pages 40, 78-79. First requirement for intelligent merchandising is accurate cost information. One of the most serious errors in figuring cost is the use of one flat molding overhead percentage for all jobs. Each molding department requires a different amount of labor and expense per dollar of direct labor. Guesswork does not provide a safe guide in establishing merchandising policies as has been shown by foundries where standard cost system has been used. VSPp (15a)

Methods of Computing Depreciation and Obsolescence. H. W. HOWITT. *Iron & Coal Trades Review*, Vol. 127, Aug. 25, 1933, page 278. The various methods in use for valuating depreciation, by the sinking fund method, annuity method and writing off pro rata over life or use of the asset, the appraisal of assets and the duties of an auditor are explained. Hap (15a)

Effect of Detail Design on Foundry Costs. J. H. LIST. *Mechanical World & Engineering Record*, Vol. 93, Sept. 1, 1933, pages 830-831. Compared are light designed but cheap and more robustly constructed but more expensive products. Today the customer wants service and value and is not buying iron and steel in bulk. Kz (15a)

Cost Price in the Foundry (Les Prix de Revient en Fonderie) HENRI CAPE. *Revue Fonderie Moderne*, Vol. 27, June 10, 1933, pages 170-173. The factors making up the price of manufacture as dependent on cost of material, labor and overhead are discussed and illustrated by examples. Ha (15a)

Cost Price in the Foundry (Les Prix de Revient en Fonderie) G. MAIREL. *Revue de Fonderie Moderne*, Vol. 27, Aug. 25, 1933, page 233. Some remarks on a paper by Capé on this subject as to how the recoverable material from castings and waste should be calculated to arrive at a correct cost price of products. Ha (15a)

Calculation of Castings (Nachwelchen Kalkulationsmethoden soll ich den Wert der Gussstücke bestimmen? Ein Beitrag zur Klärung der Kalkulationsfrage) W. HARTUNG. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Sept. 17, 1933, pages 384-387. Discusses 4 methods of calculating costs of castings for the special case of a hand wheel. A new method is proposed. GN (15a)

Estimating Problems in the Foundry (Kalkulationsprobleme beim Kundenguss) P. GOETZE. *Die Giesserei*, Vol. 20, June 9, 1933, pages 242-245. The factors which have to be taken into account when calculating prices in the foundry for small customers are discussed and examples illustrate the use of a nomogram for the determination. Ha (15a)

Plating-Shop Costing. E. A. OLLARD. *Metal Industry*, London, Vol. 43, Nov. 10, 1933, pages 471-472; Nov. 24, 1933, pages 519-520; Dec. 22, 1933, pages 615-616. Calculation of costs, overhead, advisability of piece work and paying bonuses are discussed. Ha (15a)

A View of the Copper and Economic Situation. ARTHUR NOTMAN. *Mining & Metallurgical Society of America Bulletin* No. 226, Vol. 26, Dec. 1933, pages 96-98. General. AHE (15a)

Making of Prices for Cast Iron Quantity Ware Formed on Machines (Die Preisbildung für Gusseiserne, auf Maschinen geformte Massenware) W. MAURMANN. *Die Giesserei*, Vol. 20, Sept. 29, 1933, pages 439-443. The factors entering into the price of small cast iron ware in quantity production are discussed and the possibility and desirability of standardization and cooperation among German foundries pointed out. Ha (15a)

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MANUFACTURERS' LITERATURE

Brazing Alloy

For joining brass, bronze, nickel, nickel silver, extruded brass and bronze, Monel metal and other non-ferrous metals and alloys fusing above 1300°F. the use of "Sil-Fos" is advocated in Bulletin No. 5 from Handy & Harman. General statements about it are contained in this leaflet but the company will gladly furnish specific information if you will tell them about your particular welding and brazing work. (116)

An Engineering Bronze

Revere Copper and Brass, Incorporated, has prepared a booklet giving the general properties and applications of their Herculoy, a silicon bronze which combines high strength and excellent physical properties with a high resistance to corrosion. It is non-magnetic and may be worked hot very easily. One section of the booklet gives dimensions, gages and prices. (117)

Turbo-Compressors for Foundry Cupolas

Some of the results and knowledge gained in installing thousands of turbo-compressors are given in a pamphlet from The Spencer Turbine Company. The control of the air is a vital feature, and the Spencer equipment for air service gives perfect control over the speed of the melt so that the operator can bring down the iron at the right heat, increasing the quantity as well as the quality of the output. (118)

Ferro Carbon-Titanium

A 110-page booklet received from The Titanium Alloy Manufacturing Company contains a complete discussion of titanium and ferro carbon-titanium, including the use of the latter in steel for forgings, the method of titanium-treatment of rail steel and the treatment of steel for castings with ferro carbon-titanium. A comparison with other deoxiders is given. (119)

Pyrometer Checking Set

The Thwing Instrument Company has developed the "Treasure Chest," a portable potentiometer which may be used to check thermocouples and all types and makes of pyrometers. In addition to its great utility, it is a good looking instrument, being contained in a solid walnut case with nickel plated hardware. Their Bulletin 16-1 tells about it. (120)

Insulation

Much valuable information on the insulation of industrial furnaces and ovens has been compiled by Johns-Manville and issued in loose-leaf form. Complete instructions for the installation of such insulation are given plus numerous diagrams and illustrations. (121)

Quenching Handbook

A 64-page handbook containing many charts and photomicrographs prepared by their Research Staff has been issued by the E. F. Houghton & Company. It discusses the heat treatment of steel in simple, non-technical language and reviews the results of research that has been conducted on the various types of liquids used for the quenching of steel. (122)

Rockwell Hardness Tester

Anyone will find it easy to use the Rockwell hardness tester if he follows the clear and explicit directions given in a booklet sent out by the Wilson Mechanical Instrument Company. The principle of the instrument is made clear by diagrams and several types of testers are illustrated. (123)

Die Steel

A folder from the Firth-Sterling Steel Company is devoted to their Cromovan, a triple die steel which owes its unique quality to its higher alloy content. It is recommended for use where it is advantageous to have dies available beyond the life of dies made of other steels. Its analysis, heat treatment and applications are discussed in this leaflet. (124)

Steel Castings

An attractive booklet has been issued by the Sivyer Steel Casting Company on the occasion of their 25th anniversary. Contrasting illustrations show views of their plant when it was founded and as it is today, and demonstrate very clearly the advances that have been made in the steel casting industry in 25 years. (125)

Stock List

The Joseph T. Ryerson & Son Stock List is a 232-page, carefully indexed book and while it does not provide complete information on every product, special bulletins or general data books may be obtained on any item if it is desired. (126)

Temperature and Pressure Instruments

Bulletin No. 1060 from the C. J. Tagliabue Manufacturing Company discusses their temperature and pressure instruments, giving a detailed discussion of the fully-compensated mercury construction, the complete range and listing data on all temperature instruments, as well as descriptions of pressure controllers and pressure recorders. (127)

Carbon Steels

The Carnegie Steel Company has prepared a 62-page pamphlet dealing briefly with certain aspects of steel quality, its control in the basic open hearth process and the importance of this control to the users and consumers of steel. Not the least interesting feature of the book is its classified bibliography which gives references to, and abstracts of, 52 articles on the inherent quality factors of steel. (128)

Phosphor Bronze

Price List No. 29 from The Phosphor-Bronze Smelting Company includes a discussion of the various types of their alloys—S grade for bearings in the form of castings, B grade for machinery, gears, etc., D grade for the same purpose as B though much harder, and F for purposes where great weight is to be sustained with slow motion. (129)

Silicon Bronzes

The Bridgeport Brass Company has issued a booklet devoted to their Duronze, a silicon bronze of great strength and exceptional workability recommended for the manufacture of bolts and screws by the cold heading process, Duronze II which meets the requirements for a strong hot forging alloy having fair cold working properties, and Duronze III which is characterized by great hardness combined with unusual high strength. Applications for each type are discussed. (130)

Electric Furnaces

Catalog No. 22 from The Ajax Metal Company, Electric Furnace Division, discusses the melting principle of their furnaces. Some of the advantages of this type of furnace are the automatic circulation of the metal bath, the perfect temperature control and the fact that metal loss is reduced. An attractive feature is the extremely low power consumption of these furnaces. (131)

Tool Steel

Martin steel is an alloy tool steel cast to shape, and also furnished in rolled bars and billets for forging. It is hardened in still air which practically eliminates distortions and danger of internal strains and cracking. A folder describing it has been issued by the Detroit Alloy Steel Company. (132)

Research Microscopes

A major improvement has been incorporated by the Spencer Lens Company in their new microscopes. This is the relocation of the fine adjustment button to a position at the base of the arm so that it may be operated with the hand resting on the table in the most comfortable working position. This and other new features are described in a recent booklet from the company. (133)

Industrial Furnaces

A catalog just received from the Mahr Manufacturing Company describes, illustrates and gives specifications for their annealing furnaces, oil and gas fired heat treating furnaces, rotary forging furnaces, etc., as well as Babbitt furnaces, oil and gas burners, low pressure blowers, automatic shut-off valves and kerosene torches. (134)

For Sound Castings and Ingots

The Alpha-Lux Company recommends the use of their Liquitol, a scientifically prepared fine dry powder, to insure sound iron and steel castings and steel ingots. Directions for its use are contained in a leaflet recently issued by the company. (135)

Heat and Acid Resisting Castings

Bulletin No. 21 from The Standard Alloy Company lists the most popular analyses of Standard-Alloy together with safe workable loads at different temperatures. The figures derived are from field results and tests, allowance having been made for creep, so that they represent a most conservative basis for figuring metal sections in casting design. (136)

Aluminum Bronze Die Castings

According to a folder received from the Aurora Metal Company their aluminum bronze "Stronger-Than-Steel" die castings are especially adapted for parts where great strength is necessary, where elimination of machining cost is worthwhile, and where resistance to corrosion or absence of aging changes are vital factors. They are not designed to compete with sand castings, forgings, etc., where these parts are giving satisfactory service. (137)

Bimetal

Interesting facts about Bimetal are given in a recent pamphlet from the W. M. Chace Valve Company including a simplified version of its manufacture and the way it works as an automatic operating control on products or devices where heat is a factor. Very complete instructions for determining the type and dimensions of Chace thermostatic Bimetal are given. (138)

Simplified Arc Welding

A new edition of the "Manual of Simplified Arc Welding" has been prepared by The Hobart Brothers Company. In this booklet are given all the facts necessary for the successful application of arc welding to practical work and includes useful information and suggestions derived from a vast amount of practical experience. (139)

Motor Operated Controller

A leaflet from the Automatic Temperature Control Company discusses the use of their Type 303 Multi-Position Controller in the control of fuel fired furnaces, such as batch type furnaces, pot type furnaces and continuous furnaces, indicating in each case whether the two- three- or four-position control is to be desired. (140)

Machine Gas Cutting

An unusually attractive and interesting booklet on machine gas cutting has been prepared by the Air Reduction Sales Company. The process and its applications to carbon and alloy steels are explained in dialogue form. Pictorial evidence of the range and scope of machine gas cutting is given as well as a complete discussion of the various types of cutting machines. (141)

"Lectrodryer"

A circular distributed by the Pittsburgh Lectrodryer Corporation is devoted to their new "Activated Alumina" system for drying air and gases. It can be used in controlled atmosphere annealing of deoxidized sheet, dehumidification of warehouses and special process rooms, industrial and chemical processes and gas conditioning. (142)

Sound Ingots

The Gathmann Engineering Company have compiled an 88-page book entitled "Ingot Contour and its Relation to Sound Steel." This is a very thorough discussion of the production of ingots for high quality steel and is well-worth the nominal charge of $1.00 which is made for it. (143)

Hydraulic Testing Machines

Bulletin 46 from the Baldwin-Southwark Corporation gives a short historical sketch of testing machines, the Southwark-Emery testing machine in particular. A detailed discussion of the latter machine is given, one group having a capacity of 100,000 lbs. and under, the second, medium-capacity from 200,000 to 600,000, and the third, those from 600,000 lbs. upwards. (144)

Engine Fuel

Industrial Gas Division Bulletin No. 38 from the Philgas Company discusses the advantages offered by liquefied petroleum gases for users of internal combustion engines, the two in principal use being propane and butane. (145)

Refractories

In a booklet from The Mullite Refractories Company their Shamva Mullite is called the super-refractory because it has the following excellent qualities: A definite high melting point (3300° F.), great resistance to sudden changes of temperature, ability to withstand heavy loads at high temperatures, low coefficient of expansion and resistance to corrosive slags. It may be had in all standard and special shapes. (146)

Data Book

The Dow Chemical Company has issued a new edition of the Dowmetal Data Book necessitated by recent progress in the development of Dowmetal and the rapidly increasing uses being found for this metal. Much valuable information will be found in the 64-page booklet which has sections on the properties, shop practice, specifications and available forms of the alloy. The company is prepared to furnish even more detailed information to those who require it. (147)

Shafting

A booklet from the Union Drawn Steel Company discusses in detail the production of their cold-rolled shafting, a process which involves the most scientific methods. Their three grades of shafting are described in detail. (148)

Hot Blast Stoves

H. A. Brassert & Company have distributed a leaflet which advocates the installation of their graduated filler inserts in hot blast stoves, which will increase the heating surface 50%, the checkerwork brick volume 40%, the heat transfer ratio more than 50%, resulting in the greatest possible heat capacity. (149)

Automatic Reversal of Open-Hearth Furnaces

Bulletin No. 841 from the Leeds & Northrup Company shows the need for improvement in open-hearth reversal practice and describes a method for reversing the furnace from temperature rather than from time by means of the L & N method of automatic temperature-difference reversal. The many charts and illustrations clarify the explanation. (150)

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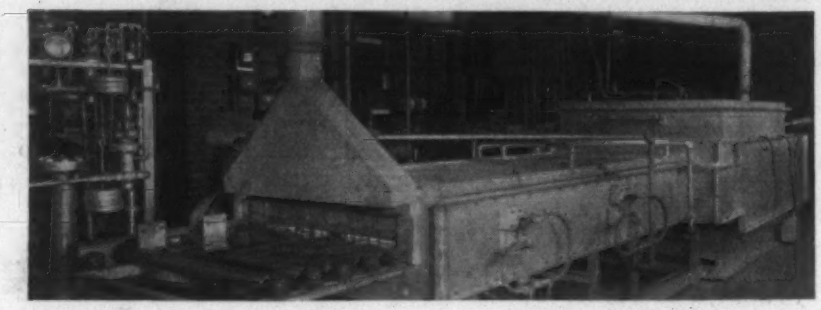
Controlled Atmosphere Roller Hearth Furnace

The new roller hearth electric furnace developed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., with its controlled atmosphere equipment bright normalizes sheet steel material such as that used for deep drawing. The work is carried through the furnace continuously on driven rolls. It emerges normalized, free from scale, bright and clean. This furnace has numerous uses, some of which are continuous strain removal, normalizing sheet or tubes and con-



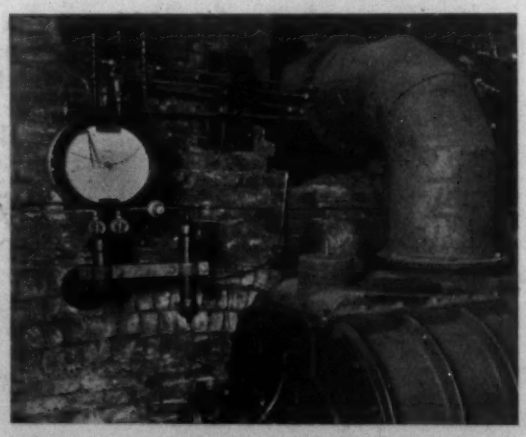
tinuous brazing. The gas apparatus uses inexpensive natural gas. The gas is mixed with the proper proportions of air, passed through a heated tube, over a special catalyst, partially combusted and partially relieved of moisture before passing into the furnace chamber.

Kunial

A press release from the Imperial Chemical Industries, Metals Ltd., London, indicates that another trade name is to be brought into the field of copper-base alloys. This is "Kunial," which conveys the fact that the alloys thus designated contain copper, nickel and aluminum. The term is applied not only to these ternary alloys, but also, as an adjective, to brass, nickel brass and bronze, to designate quaternary alloys that are precipitation-hardenable. Evidently these alloys, which have been described from the scientific and technical points of view in various American and foreign journals in the past few years, are about to have active commercial development in England. The gradations in properties that can be obtained by controlled precipitation-hardening, and the advantages of forming and machining in the soft state, prior to hardening, are stressed in this press release.

Air Weight Controller

The new Air Weight Controller of the Foxboro Co., Foxboro, Mass., comprises a temperature and pressure compensating mechanism which provides a continuous indication of the **weight-rate**. This is achieved by the "continuous sampling" method whereby a small portion of the air supply flows through the air-tight case and allows the compensating mechanism to respond to line pressure and temperature with practically no lag. Consequently, the instrument does two things. First, it pen records the weight-rate—or the air flow rate expressed in **standard cubic feet** (n.p.t.) which is equivalent. Second, it commands a diaphragm-motor or other power device whereby the gravimetric quantity-rate of air delivered to the blast furnace, cupola or other processing apparatus is automatically regulated.



The new Air Weight Controller can be used in conjunction with practically any type of blowing equipment. When used to control the air flow to a cupola, an orifice plate or other primary device is installed directly in the blast pipe and the instrument commands a butterfly or other suitable valve. In controlling the flow to a blast furnace, the orifice plate is located on the suction side of the blower. The control mechanism can be arranged to command the turbine or blowing engine governor so that the desired quantity of air will be delivered with the least consumption of fuel. An alternative installation is to place the controlled valve in a bypass line around the blower. The entire control equipment can be installed in a few hours by an experienced pipe fitter.

New Hard Surfacing Electrode

"Wearweld," a new shielded arc electrode for building up steel surfaces to resist shock and abrasion, is announced by The Lincoln Electric Company, Cleveland, Ohio.

Deposits made with this electrode are air hardening alloy steel with an unusual combination of hardness and toughness, according to the manufacturer. Wearweld can be used to build up all steels other than those of the austenitic type. It is said to be particularly valuable for facing parts subjected to rolling or sliding abrasion, batter, sand abrasion and repeated impact. The deposited metal has exceptional hardness, depending to some extent upon the composition of the base metal. A single layer on mild steel has a hardness of 40 to 45 Rockwell C. Additional layers will have a hardness of 48 to 52 Rockwell C, it is claimed. On .70 carbon steel, a single layer will have a hardness of 50 to 55 Rockwell C. The heavy coating of this electrode provides a shielded arc allowing the transfer of molten metal to take place under non-oxidizing conditions. It also provides a layer of slag which further protects the metal from the harmful effects of the air and causes the weld metal to solidify in a smooth uniform bead. Good deposits may be made in very thin layers if required. If shaping is necessary, the deposit may be ground to size. Wearweld electrode is manufactured in two sizes—one quarter and three sixteenth inch diameter —and 18 inch lengths. It is packed in 50 lb. steel containers.

New Insulation Block

Johns-Manville, New York, N. Y., announces a new and improved Superex Insulation Block which will safely withstand temperatures up to 1900° F. This increase in temperature resistance has been effected by the use of a special calcined diatomaceous silica. Like the previous Superex, it is bonded with asbestos fiber. Superex is particularly adapted to the insulation of high temperature boiler furnaces, open hearth and glass tank regenerators, hot blast stoves, ceramic and rotary cement kilns, and various types of high temperature metallurgical furnaces. In addition to higher temperature resistance, this new Superex Block also has a lower density and a greater insulating value.

Textolite Roll-Neck Bearings

An improved line of Textolite roll-neck bearings, designed to reduce rolling costs, has been announced by the General Electric Company, Schenectady, N. Y. The range of capacities of these bearings covers cylindrical segments in sizes from 5″ I.D. to 30″ O.D. with any desired wall thickness, any arc contact up to 180°, and any length up to 28″. With several different grades of bearing linings covering a wide range of properties, it is possible to select the proper size and grade of Textolite bearing linings for each application. Grade No. 2020, designed for heavy-duty applications such as plate mills, blooming mills, or large rail or structural mills, is a graphite filled, fabric base material using an extra heavy four-ply interwoven fabric. This tough impact-resistant lining is also recommended for use as the initial application in a change-over from bronze bearings where the roll necks are likely to be scored or rough. Grade No. 113, a general-purpose bearing for rod, bar, skelp, and merchant mills, is a fabric base material using a medium weave fabric. On the finishing stand of an 18″ sheet bar mill, where the life of bronze bearings lasted while from 2500 to 5000 tons of rolled material passed through the mill, Textolite bearings have averaged over 100,000 tons. Grade No. 2001 is a graphite filled, fabric base material using a fine weave fabric. It offers a smooth, fine grained bearing surface which is ideal for hot-strip mills where it is necessary to have a minimum of spring in the bearings. It is the least resilient of the Textolite grades but has considerable toughness. Grade No. 575X is made especially for copper and brass mills, steel-rod mills and other machines where impact loads are light. This grade has a closer structure, and when properly applied, is the most economical bearing to use both from the standpoint of first cost and of power saving. For example, the running light power input on a 10″ rod mill finishing stand was reduced 60 per cent, and the input with steel in the mill was reduced 44 per cent as compared with bronze bearings. In addition to these grades which are used for radial bearings, two grades are made in slab form for use as thrust collars. In some cases thrust collars may be renewed without removing the chucks from the mill. Water is the only lubricant recommended. In order to insure an ample supply of water, it has been found desirable to use two sprays, one at the "leaving" side of the bearing for cooling, and one directed into the chamfer on the "entering" side for lubrication. The principal field of application for Textolite bearing linings is at speeds greater than 120 feet per minute where water lubrication is used. At lower speeds, the advantages over bronze or babbitt bearings is not so great, and for these speeds Textolite is recommended only where the impact loads are so high that they would pound out babbitt or would cause pitting and scoring in bronze bearings.